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(54) **Digital platemaker system and method.**

(57) A digital plate maker system to receive graphics and text data and selectively discharge incremental areas of a charged electrophotographic member to form thereon the latent images represented by the graphics and text data, the imaged member thereafter being toned and output from the system. Thereafter, the toned image may be fused on the member and the member being used in an offset lithographic printing press. The digital platemaker system includes an optical system which may form a maximum of 22 individual rays which are direct deflected twice through a field flattening lens and then onto the charged member. The optical system further includes an optical scale or grating which provides electrical signals indicating the precise location of the individual rays along scan lines on the member. The digital plate maker system further includes an electronic system which generates electrical signals to form the 22 individual rays. The text data is used to modulate signals produced by the graphics data, the result of the modulation being the beam control signals

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used to form the 22 individual rays. The digital plate maker system further includes a toning system which provides a vertical meniscus which is essentially stationary with the electrophotographic member as the electrophotographic member is rotated past the toning station.

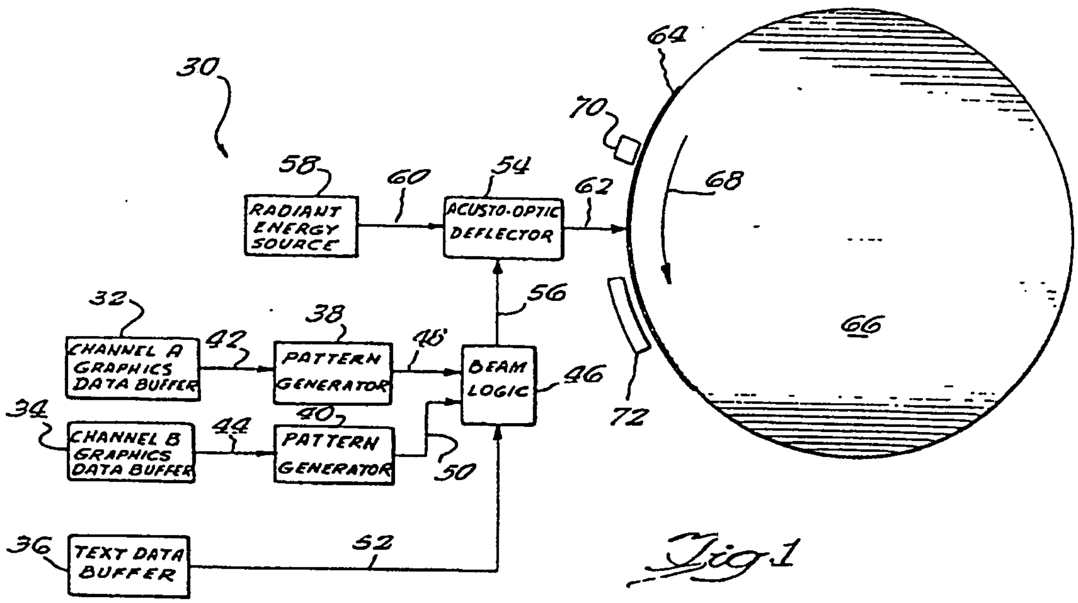

Fig 1

CROSS-REFERENCE TO RELATED APPLICATION AND PATENT

References made hereinafter to a co-pending application Ser. No. 11,320 filed February 13, 1979 and entitled "DIGITAL LASER PLATE MAKER AND METHOD", the applicant being Lysle D. Cahill.

References also made hereinafter to a patent No. 4,025,339 issued on May 24, 1979 to Manfred R. Kuehnle.

Both the application and the patent above identified are owned by the Assignee of the application herein.

DIGITAL PLATE MAKER SYSTEM AND METHOD

The field of the invention comprises apparatus and a method for imaging electrophotographic members by means of radiant energy devices such as lasers, the imaged electrophotographic members being thereafter used for printing. In the case of lithographic offset printing, the actual imaged member itself is treated to render toned and untoned parts hydrophobic and hydrophilic respectively and the member comprises the plate without further processing. In other cases, the toned electrophotographic member may be used as an information source by reading the images or projecting them if transparent or photographically reproducing them if desired. The preferred use of the invention is to make the printing plates upon metal such as stainless. Each of these substrates is coated with a type of photoconductive coating which will be described hereinbelow.

In the printing industry, printing plates for printing both graphics and text have in the past been produced manually with the graphics images being reproduced using the so-called half tone process. In this process several photographic steps are used to reproduce the graphics image in an array of dots of varying size to reproduce the image on the printing plate. Text information has in the past been hand set, but now may be set by machine under control of electronic devices.

Forming printing plates carrying both graphics and text images may involve several steps, especially when color graphics are to be reproduced. In such a case, several color separation plates must be made for each color to be printed with the text information located on the plate in which color is to be printed. When text information is to be located within the field of the graphics image, additional steps are required to form the solid printing areas for the plates in that particular color and to remove the graphics image from those same text areas on the remainder of

color separation plates. This of course adds to the number of processed steps required to produce the desired graphics and text images. The steps of forming the graphics image to be printed in the graphics field is commonly known as overburning while the process of removing the graphics image from those same text areas in the other color separation plates to be printed is referred to or is commonly known as stripping.

In overburning, the negatives which form the graphics image and the text image to be formed in that field are overlayed one on another to form the desired color separation printing plate. In stripping, other techniques must be used to remove the graphics information from those same text image areas.

The process of forming printing plates containing both graphics and text data recently has been effected using essentially the same methods as were performed manually. Advanced systems however are able to compile from various input devices data which may be used to form both graphics and text information on a printing plate. But these systems have their drawbacks in that separate scanning cycles must be performed to form the graphics and text images on a single printing plate and in addition, complex switching circuits must be constructed to switch between text and graphics image formation when text images are to be formed within the field of a graphics image.

The apparatus and method of the present invention overcome these drawbacks presented by the manual and electronics systems by providing a system which in one pass of a beam of radiant energy may form both graphics and text images in response to graphics and text data input thereto. Formation of the graphics and text images may occur independently of one another so that different imaging schemes may be used to form scaled densities

of the graphics images and the binary densities of the text images.

Formatting of the data is such that the graphics data contains information related to the relative scale densities of incremental areas of the graphics image with the remainder of the graphics data being a nullity to clear the surface of a charged electrophotographic member. The text data ist formated such that it does not affect the formation of the images carried by the graphics data except in locations where text images are to be formed.

Formation of text images within the field of graphics images for several different color separation plates is performed simply by reversing the logical sense of a control bit of every text data digital word. Thus to produce text images of one color such as blue a multi-color printed graphics image, the same data may be used for all of the color separation plates with the control bit for the color separation plate used to print the color blue set to one logical state and being set to the other logical state for the reminder of the separation plates.

Thus the apparatus and method of the invention provide for imaging of an entire printing plate with graphics and text information in a single pass of a beam of radiant energy.

The apparatus and method of the invention include an optical system in which a beam of radiant energy from a monochromatic source such as a laser is used selectively discharge and leave charged incremental areas of a charged electrophotographic member. Part of the beam is split and used as a reference beam. The remainder of the beam is modulated to provide a scanning beam or a fine beam comprised of individual rays of radiant energy

with each ray able to discharge an incremental of the member. The reference beam and scanning beam or fine beam are aligned vertically with one another with the vertical alignment being used in an optical grating system to precisely determine the location of the scanning beam along the surface of the member. A field flattening lens is used in which both the reference and fine beams passed therethrough and back again to the member, the field flattening lens providing the maintenance of a focused image on the surface of the member across every scan line.

A common technique to determine the instantaneous position of the scanning beam along a scan line of the member is to employ an optical scale or grating composed of alternate bars or space of opaque and transparent or reflecting surfaces or areas. These alternating spaces occur at intervals equal to the spacing between elements on the member to provide electrical signals indicating the alignment of the scanning beam with the elements. Light passing through or being reflected from such a grating is detected with a photosensitive device which converts the energy into electrical pulses.

Over relatively short scan widths, by 10" or so, the problem of accurately gathering or collecting light pulses from an optical scale and directing them to the photosensor is readily accomplished with relatively simple optics. In much greater scan widths however the cost of collecting optics rises exponentially and quickly reaches prohibitive levels. The acting apparatus of the invention herein has an active scan length of 24". The cost of conventional optics for collecting a reference beam across such a length and establishing a beam feed-back within 1/300" accuracy is prohibited.

The concept of using a glass rod or fiber in such a grating collection system is known. The principle used

to eliminate the fiber along its cylindrical surface to collect the intercepted energy and detect the intercepted energy as it exits the rod at either end thereof. Original results with a short piece 3/8 inch diameter glass provided poor results, it being believed that most of the energy was transmitted through the diameter of the rod so that the light output at either end of the rod was too low to be of use.

The concept of using a hollow metal tube with a high reflective interior surface to include transmissive losses also was investigated. The tube used had a very narrow length-wise slit to prevent entrance of the radiant energy reference beam, and a photosensor was mounted at one end with a mirrot located at the other to reinforce the refected energy levels. It was believed that the reference beam would strike the rear internal surface of the tube and give rise to multiple reflections which would propagate along the tube and result in a useful output level at the end mounted sensor. The optical surface smoothness on the interior was difficult to control and in turn satisfactory reflections and distributions were not obtained. At a consequencey thereof, signal levels obtained from the hollow metal tube vary greatly as a function of the beam position from the sensor along the scan length. Automatic gain and compensation techniques were implemented to modulate the electronic signal from the sensor, but none of these proved successful. In reevaluating the glass fiber technique, it was believed that if the transmissive losses of energy could be prevented by containing the light within the fiber as within the hollow tube, the rod collecting scheme might succeed.

A 1 3/4 inch rod was used because the internal diameter of the existing hollow tube was about 2 inches and this would faciliate concentric mounting of the rod within the tube, and would further minimize further energy

losses by decreasing the concentric area. Essentially the glass fiber rod was mounted within the length of the tube. Initial tests met with little success until a strip of masking tape was attached to the far side of the rod opposite the beam entry point. Increased energy level from the non-reflecting surface of the tape was immediately recognized to be the result of eliminately the air-gap index of refraction (a high loss component) while containing and reflecting the entrapped energy. It was quickly determined that highly reflective material such as a typewriter corrector fluid applied to rod's cylindrical surface would be highly efficient in preventing the transmissive loss and aid in providing good Lambertian distributions. It was later determined that it was not necessary to coat the entire surface of the cylinder or rod. A narrow stripe of about 1/4 of an inch wide along the rod proved to be more than adequate. Test results for rods of 0.78", 1.0", 1.5" and 1.75" indicated that test results for the bar collector used in the present invention would be obtained with a bar diameter somewhere between 1.5" and 1.75".

Two prior art patents which disclose using a bar collector in an optical scanning or sensing apparatus are U.S. Patents 4, 040,748 and 4,040,745. These patents however do not appear to disclose the use of a bar collector over the length required by the invention herein.

The apparatus and method of the invention further include an electronic system which performs the graphics and text imaging process of the invention. As has been explained, this method of the invention provides for the intermixed formation of graphics and text images on the electrophotographic member in one sweep or pass of the imaging beam of radiant energy. To allow formation of the graphics images with a processed

desired, the electronics provided are such that formation of the graphics and text images occur independently of one another. That is to say, that unless there is text image to be formed in a particular location on the charged member, formation of the graphics image occurs independently of the text.

Electrophotographic member used with the apparatus and method of the invention allows the incremental areas to be imaged which are finer than that presently available and allows those elements to be formed at a more rapid rate and with less energy than as previously been provided for. This electrophotographic coating will be further referred to hereinafter.

The apparatus and method of the invention further include a toning system which applies minute toning particles to the areas of the latent image, which remain charged. This toning system provides an essentially vertical meniscus closely adjacent the plane at which imaging of the member occurs so that there is a minimal loss of voltage representing the latent image on the electrophotographic member from imaging to toning. Toning systems are known in which toning fluid is applied to the bottom of a rotating drum carrying the electrophotographic member wherein the distance from the imaging to the toning is minimal. In the apparatus of the present invention however a large drum is used which rotates relatively slowly so that if a toning system were used which is located at the bottom of the drum, essentially all of the latent image would become discharged by the time the member was rotated to the toning station. Therefore, the toning station must be located closely adjacent the plane in which imaging occurs, which requires that toning fluid be applied in a layer which is essentially vertical.

This vertical layer or meniscus is provided by used a supply system or pressure system sealed to the atmosphere, allowing toning fluid to escape from the pressure as the layer or meniscus of toning fluid and controlling the rate of escape of the toning fluid by a valve admitting atmosphere to the otherwise sealed pressure system so that the rate of flow of the toning fluid is essentially equal to the movement of the member past the toning station, and there is provided a vertical meniscus of toning fluid which is essentially stationary relative to the member.

SUMMARY OF THE INVENTION

A digital plate maker system and apparatus which receives binary digital graphics and text data to form a toned latent image on electrophotographic member, the toned image thereafter being fused to the member and the member being used as a printing plate in an offset lithographic printing press. The plate maker system including an optical system, an electronics system and a toning system.

The optical system providing 22 individual rays of radiant energy with which to discharge incremental areas of the electrophotographic member. The optical system further providing field flattening to maintain a focused image of the individual rays across every scan line across the original image. An optical scale or grating system is provided which receives a reference beam of radiant energy vertically aligned with a fine beam which may be comprised of the 22 individual rays, the bar collector receiving the reference beam across the length of every scan line. The bar collector directs the radiant energy from the reference beam to a sensor which provides electrical signals indicating the position of the fine beam along the scan line.

A method of forming the text and graphics images on the member is implemented in electronic system. The graphic data is used to generate beam modulation signals to form the desired number individual rays. The text data is used to modulate the beam modulation signals so that text images may be overlayed on graphic images or formed outside of fields of graphics images.

A toning system is used in the digital platemaker system to tone the latent images. The vertical meniscus, which as it flows is essentially stationary relative to the movement of the imaged electrophotographic member as it

passes a toning station.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of an apparatus for making printing plates as constructed in accordance with the invention and uses the method of the invention;

Fig. 2 is a left-side elevation of the apparatus;

Fig. 3 is a plan view of the apparatus illustrated in Fig. 2 with the cover of the optical system and the cabinetry covering the drum removed;

Fig. 4 is a schemmatic diagram of the left-hand optical system of the apparatus;

Fig. 5 is a partial schematic diagram of the optical system illustrated in Fig. 4 taken along the lines 5-5 in the direction indicated;

Fig. 6 is a partial schematic diagram of the optical system illustrated in Fig. 4 and taken along the lines 6-6 in the direction indicated;

Fig. 7 is a partial schematic diagram of the optical system illustrated in Fig. 4 taken generally along the lines 7-7 in the direction shown;

Fig. 8 is a representation of elements of a field flattening lens system;

Fig. 9 is a schematic diagram of the optical scale or grating system illustrated in Fig. 4 taken generally along the line 9-9 in the direction shown;

Fig.10 is a top view of the bar collector illustrated in Fig. 9;

Fig.11 is a chart of a field of graphics image areas and text pixels which is used in the explanation of the invention;

Fig.12 is a chart of a field of graphics pixels which is used in the explanation of the invention;

Fig. 13 is a chart of a field of text pixels overlaid with four graphics pixels, which is used in the explanation of the invention;

Fig. 14 is a more detailed block diagram of the electronics and optical system of the apparatus;

Fig. 15 is a more detailed block diagram of the pattern generators illustrated in Fig. 14

Fig. 16 is a more detailed block diagram of the beam logic circuit illustrated in Fig. 14;

Fig. 17 is a chart illustrating which groups of individual rays are controlled by individual bits of text data words which is used in the explanation of the invention;

Fig. 18 is a more detailed block diagram of the multiplex and gating circuits of Fig. 16;

Fig. 19 is a block diagram of the toning system of the apparatus;

Fig. 20 is a perspective view of the toning station and drum;

Fig. 21 is a perspective view of a shoe used in the toning system illustrated in Fig. 19;

Fig. 22 is a sectional view of a charging station and is a sectional view of the shoe illustrated in Fig. 21 showing the relationship of the charging station and shoe to the drum, and

Fig. 23 is an exploded view of a portion of the interface between the drum and the shoe illustrating the relative positions of the electrophotographic member and the toning fluid.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the preferred embodiment, the imaging device receives digital data representing the graphics and text images to be printed or otherwise reproduced. This digital data is received from a compiling system which obtains raw data from such as optical scanning system, text input stations, etc., and compiles or formats the data representing the graphics and text materials into a form which may be used by the imaging device of the invention herein. The data received by the imaging device also may be generated or synthesized by a computer or by other means and may be presented to the imaging device from a memory in which it has been stored or it may be presented on line as it is generated or synthesized if the generation or synthesization rate if equal to or less than the imaging rate of an imaging device herein.

The output of the imaging device herein is an electrophotographic member carrying a toned latent image of charged and discharged incremental areas formed in response to the digital data. The toned member thereafter may be fused and processed for use as a printing plate in an offset lithographic printing press with the toned areas carrying ink to a receptor to form the tonal graphics and text images. If color printing is desired, as many electrophotographic members carrying toned latent images are formed, as there are colors which are desired to be printed, one member carrying a toned latent image for each of what is commonly known as a color separation.

The imaging device or imager used in the preferred embodiment of this invention uses a lazer beam to image an electrophotographic member that includes a photoconductive coating that previously has been charged. The member is carried on a rotary drum, is toned on the drum and thereafter may be used to transfer the toned

image or to serve as a medium for projection or printing of the image. In the case of printing, the toned image is used to carry ink in a printing press, the member having been treated to achieve hydrophilic and hydrophobic areas to enable offset lithographic use of member as a printing plate.

The preferred use of the imaged member herein is as a printing plate and has the same type of photoconductive imagable coating is preferably the receptor of the lazar beams which comprise the output from the apparatus of the invention. Such coating is that which is described and claimed in U.S. Patend 4,025,339.

The apparatus and method of the invention may best be understood by considering that the binary digital data input to the apparatus is used to binarily modulate a beam of radiant energy from a lazar to selectively discharge and leave changed incremental areas of a charged electrophotographic member. Thereafter, the selectively charged and discharged pattern or image carried on the member is toned and output from the apparatus.

The electrophotographic member is carried on the outer circumference of a drum which is rotated along its longitudinal axis. Charging, imaging and tonig of the member on the drum occurs sequentially at adjacent stations as the member is moved past the stations by the rotating drum. Charging of the electrophotographic member may be of any means desired and in the preferred embodiment occurs by placing adjacent the outer circumference of the drum a wire having a high voltage applied thereto. Toning of the imaged member occurs by applying to the member a quantity of carrier fluid obtaining toner particles. The charging and toning occurring at stations respectively above and below an imaging plane. Imaging of the charged electrophotographic member occurs by passing a fine beam of radiant energy from a lazer across the surface of the

member in image lines which are parallel to the longitudinal axis of the drum and lie in the imaging plane. Imaging of the entire surface of the charged member occurs in sequential image lines as the member is moved by the drum past the imaging plane.

The digital input to the imaging apparatus is in the form of two channels of graphics data and one channel of text data. Each digital word of the graphics data is used to form a picture element or a graphics pixel on the electrophotographic member. Every imaging line is comprised of two scan lines of graphics pixels with each channel of graphic's data respectively controlling the forming of graphics pixels in one scan line.

The text data controls the formation of text pixels across the entire scan line and therefore only one channel of text data is required. Every word of the text data is comprised of 8-bits of information with the least significant six bits each controlling the binary density of a text pixel, the next least significant bit serving as a control bit, and the most significant bit not being used.

The graphics data and text data are formated such that the may individually form respective graphics or text images across the entire area of the electrophotographic member. The electronics of the invention herein uses both text and graphics data to form one channel of laser modulation signals. Further, in the imaging apparatus herein, the information carried by the text data is used to gate the formation of the individual rays of the fine beam of radiant energy, each of which rays are used to discharge an incremental area on the charged electrophotographic member. Simply stated, it may be thought of that the text data is used to gate or modulate the formation of graphics pixels in response to the graphic data. Thus if the text data is a nullity, no text images are to be formed on the

member, the information carried by the graphics data will form the graphic image represented thereby and discharge the remainder of the member.

Where the text data contains information representing a text image to be formed on the member, the text data may either inhibitit the formation of individual rays of the fine beam or depending on the logical state of the control bit included in each word of text data. When the text data inhibits the formation of individual rays of the fine beam, the text image is formed on the member which will be toned and in the printing plate will carry ink to the receptor to print a solid image. This is a case where black text is desired on any background. When the text data forms individual rays of the fine beam, text pixels are discharged on the member with the discharged areas of the member forming areas of the printing plate which do not print on the receptor or which remain clear. This is the case where clear text is desired within a graphics image. Within the preferred embodiment of the invention, the text pixels are nine times more numerous than the graphics pixels, i.e., for every graphics pixel, there are nine text pixels which may be discharged or left charged. The resolution provided by the text pixels is not however nine times the resolution provided by the graphics pixels because of overlap of the text pixels. Of course it will be understood that the electrophotographic member is not physically divided into pixels of any type, scan lines or image lines, and that these terms are used only to describe the operation of the imaging apparatus and method.

Referring now to Fig. 1 of the drawings, the apparatus of the invention there is illustrated diagrammatically is indicated generally by the reference character 30. Two channels of graphics data are received by the apparatus respectively on channel A and channel B graphics data buffers 32 and 34. Text data is received

into text data buffer 36. The graphics data contained in data buffers 32 and 34 individually are applied to pattern generators 38 and 40 over leads 42 and 44. In pattern generators 38 and 40, the density information carried by the digital words of the graphics data are converted into patterns of elements which are to be formed in graphics pixels on the member, the pixel patterns representing the densities indicated by the graphics data. The pattern information produced by pattern generators 38 and 40 then is applied to modulator 46 on leads 48 and 50 together with the text data from text data buffer 36 on lead 52. In modulator 46, the text data is used to modulate the pattern information from pattern generators 38 and 40. The output of modulator 46 which is applied to acousto-optic modulator 54 is the ray data which controls the formation of individual rays in the fine beam. The output of modulator 46 is carried to the acousto-optic modulator 54 on lead 56. A radiant energy source 58 is provided which produces a beam of radiant energy 60 which essentially at one wave length and which is directed to acousto-optic modulator 54. Radiant energy source 58 is in the preferred embodiment a lazar with the wave length of the beam of radiant energy 60 being chosen to most advantageously discharge area of the electrophotographic member. Acousto-optic modulator 54 modulates the beam of radiant energy 60 to provide a fine beam 62 of radiant energy comprised of a plurality of individual rays and in some cases as little as a single ray.

The fine beam 62 is directed onto an electrophotographic member 64 carried on a drum 66 rotating in the direction indicated by arrow 68. The thickness of member 64 is exagerated in Fig. 1 only so that member 64 may easily be seen on the circumference of drum 66. Charging of member 64 occurs at charging station 70 prior to the time at which fine beam 62 is applied to member 64 and toning of member 64 occurs after imaging by fine beam 62

at station 72.

It should be pointed out that while the preferred purpose of the invention is to make offset lithographic plates by electrostatic techniques described herein, any use of an electrophotographic member will find advantages where a member has been imaged according to the invention.

It will be appreciated that in forming several different color separation plates, it may be desired to form text images of a single color (for example blue text) in a field of a graphic image or otherwise. Thus in the blue printing separation plate, the text image must be found solid. On the other color separation plates that same area must be cleared so that only the color blue will be printed therein or the recepta. Thus by selectively using the solid forming and clearing capabilities of the text data, one may form the solid printing blue text image in the field of graphics or otherwise as may be desired.

Turning now to Fig. 2 and 3, the preferred embodiment of the digital plate maker is illustrated including some of the cabinetry provided therewith. The apparatus 30 includes an optical cabinet 80 which encloses a left-hand optical system 82 and a right-hand optical system 84. Drum 66 extends the width of the left-hand and right-hand optical systems 82 and 84 so that an electrophotographic member carried thereon may be simultaneously and separately imaged by respective optical systems. Drum 66 is supported at each end by supports 86 and 88 and is rotationally driven by motor 90. As shown in Fig. 2, the drum is enclosed by a housing 92, which protects a member carried on drum 66 from ambient light. Optical cabinet 80 and housing 92 adjoin each other there being only a small slit opening between them through which the fine beam passes on its way to the charged electrophoto-

graphic member.

The electrophotographic member is held on drum 66 by a magnetic chuck which is formed of magnetic strips extending the length of drum 66 at the circumference thereof. The magnetic field produced by these magnetic strips is strong enough so that an electrophotographic member having a substrate of such as stainless steel will be securely held on the drum. In the preferred embodiment, the drum circumference is 1250mm. while the drum length is 1,100mm. The drum is continously rotated at a speed of 0.125RPM which corresponds to 180 revolutions per day or 8 minutes per revolution. This provides a drum speed of 2.6mm per second.

The center line of the charging station 70 is arranged to be 25 degrees above the image plane, while the center line of the toning station 72 is arranged to be 30 degrees below the imaging plane.

The maximum size electrophotographic member which may be carried by the drum 66 is a member which is 1.040 by 1.040 mm and the area of the member which may be imaged by each of the left and right hand optical systems is 50 cm. axial of the drum by 70 cm. circumferential of the drum or an area which is 20 x 28 inches.

A cabinet is provided in which the toning tanks and pumps are contained with the hydraulic and nomadic connections between cabinet 94 and toning station 72 (not shown in the drawings for clarity purposes). Mounted on the exterior of cabinet 80 are two lazers 96 and 98, which provide the radiant energy respectively to the left-hand and right-hand optical systems 82 and 84. The entire apparatus 30 is supported by a frame 100 having the general configuration of a table. Auxillary equipment for operating the apparatus 30 such as power supplies for the lazers 96 and 98 serve or

control electronics for the motor 90 and auxillary tanks for the toning system may be mounted under frame 100, and are not shown in Fig. 2 for clarity of the drawing.

As may be seen in Fig. 3, the left-hand and right-hand optical systems 82 and 84, are mirror images of one another so that a description of one is a description of the other. Referring also to Figs. 4, 5, 6 and 7, lazer 96 provided the beam of radiant energy 60 to special filter 110 which provides what may be termed a pinhole aperture to obtain a desired cross-sectional size of the beam. The beam 60 is transmitted through special filter 110 to folding mirror 112 which deflects beam 60 to beam splitter 114. A portion of beam 60 is transmitted through beam splitter 114 and forms a reference beam 118 which is deflected by folding mirror 120 and 122 to a spot forming lens 124. The portion of beam 60 which is deflected by beam splitter 114 is directed to acousto-optic deflector 54 which forms of beam 60 the individual rays which have been refered to as the fine beam 62. Fine beam 62 exits acousto-optic deflector 54 and passes through spot forming lens 126 and passes under folding mirror 128. Reference beam 118 passes through spot forming lens 124 as deflected by folding mirror 128. After fine beam 62 passes under folding mirror 128, fine beam 62 and reference beam 118 are vertically aligned with one another through the remainder of the optical path. Referring to Fig. 5, reference beam 118 which is transmitted through beam splitter 114 is represented by a crossed line indicating the light in reference beam 118 is exiting the drawing figure. Folding mirror 128 also is shown in Fig.5 located above fine beam 62 after it passes through spot forming lens 126 and the circle at the center of folding mirror 128 representing that reference beam 118 is directed into drawing Fig. 5. Fine beam 62 and reference beam 118 then are deflected by folding mirror 130 with the crossed lines in Fig. 5 on folding mirror 130 indicating the light is exiting

from the drawing figure while the circles on folding mirror 130 on Fig. 6 indicate that the light is entering the drawing figure.

Fine beam 62 and reference beam 118 then are passed through a relay lens 132 to a folding mirror 134. Again the crossed lines on folding mirror 134 on Fig. 6 representing that the beams are exiting the drawing figure. As also is shown in Fig. 7, beams 62 and 118 are deflected by folding mirror 134 through an f θ lens system 136 to a galvanometer mirror 138. Galvanometer mirror 138 is rotatatbly oscillated in the directions indicated by arrow 142 and directs fine beam 62 back through the f θ lens system 136 through an aperture 144 extending through the front plate 146 of cabinet 80 and then onto the charged electrophotographic member 64. Reference beam 118 is deflected by galvanometer mirror 138 back through f θ lens system 136 and onto a folding mirror 148 to an optical scale or grating system 150.

It will be noted that the deflection of fine beam 62 and reference beam 118 in horizontal directions by galvanometer mirror 138 does not disturb the vertical alignment of these two beams so that the position of reference beam 118 may be sensed by the optical scale or grating system and precisely locate the position of fine beam 62 which is used to image or write the images on the electrophotographic member 64. Galvanometer mirror 138 deflects fine beam 62 through a scan line 152 illustrated in Fig. 6 and deflects reference beam 118 along a scan line 154 lying on deflecting mirror 148. The extent to which the galvanometer mirror deflects fine beam 62 and reference beam 118 are represented in Fig. 4 by dashed lines 156.

It will be noted that as illustrated in Figs. 6 and 7, fine beam 62 and reference beam 118 are located below the imaging plane defined by fine beam 62 as it passes

through aperture 144 and is directed onto electrophotographic member 64. The f Θ lens system 136 provides field flattening for both fine beam 62 and reference beam 118 so that they may be maintained in focus respectively across the surface of the electrophotographic member and across the surface of the optical scale or grating system 150. It will be noted that the distance travelled by fine beam 62 along an optical path from spot focusing lens 126 to member 64 is equal to the distance travelled along the optical path by reference beam 118 from spot forming lens 124 to optical scale or grating system 150.

The spacial filter or folding mirrors, beam splitters, spot forming lenses, relay lens and galvanometer mirror are all common optical elements which readily may be contructed and arranged in a system as has been described as may be desired.

In the preferred embodiment this spot forming lenses have a focal length of 26 mm, the relay lens has a focal length of 200 mm and the F Θ system has a focal length of 870 mm. The distance between the spot forming lens and the relay lens is 559.2 mm while the distance between the relay lens and the F Θ lens is 1,190 mm. The distance from the F Θ system to the focal plane at the electrophotographic member 64 and the optical scale system 150 is of course 870 mm.

The f Θ lens system 136 is illustrated in Fig. 8 and comprises elements L1 through L4 having surfaces defined by radii Rl through R8 as shown.

The lens of Fig. 8 comprises from the object end a first positive group L1, L2 having a concave object side surface; a second positive group L3 having a flat object side surface; and a third positive group L4 having a flat object side surface and a convex image side surface.

The lens of Fig. 8 is defined substantially by the data of Table I, as scaled to a focal length of 870 mm;

LENS		Radius	Axial Distance Between Surfaces (mm)	N_d	V_d
	R1	- 161.744			
L1			15.00	1.617	36.6
	R2	00			
			6.97		
	R3	-216.311			
L2			28.871	1.523	58.6
	R4	-213.119			
			0.20		
	R5	-2575.204			
L3			18.06	1.523	58.6
	R6	-264.288			
			0.20		
	R7	00			
L4			13.00	1.523	58.6
	R8	-265.847			

The lens disclosed may of course be scaled otherwise as is desired.

The acousto-optic deflector 54 is capable of separating beam 60 into as many as 22 individual rays or beamlets which form fine beam 62. In the preferred embodiment as many as 22 individual radio frequency signals may be applied to acousto-optic deflector 54 to deflect the 22 individual rays each radio frequency signal being capable of deflecting one individual ray. Acousto-optical deflector 54 is constructed and arranged so that the individual rays which are deflected from beam 60 are aligned vertically in fine beam 62 and so that in the focused images formed on the electrophotographic member 64 are arranged adjacent and spaced equidistant from one another. Thus a radio frequency signal of the first frequency will form one individual ray while the next radial frequency signal will form an adjacent ray and so on.

In the preferred embodiment acousto-optic deflector 54 is capable of deflecting 22 individual rays and although deflector 54 operates on the principle of acoustically deflecting the individual rays other deflection apparatus may be used in place of.

The optical scale or grating system 150 comprises a grating 160, a bar collector 162 carrying a narrow stripe of reflective material 164 on the outer surface thereof and a sensor 166 such as a photomultiplier tube. As is illustrated in the drawing figures 9 and 10 the optical scale or grating system extends the entire length of the scan lines across which fine beam 62 and reference beam 118 are deflected. In turn grating 160 and bar collector 162 extend over this length of the scan lines across which the beams may be deflected.

Grating 160 is an elongate transparent member carrying alternating opaque and transparent lines or spaces having a frequency related to the frequency of the rows in an imaging line. Grating 160 is arranged so that reference beam 118 is deflected across the opaque or transparent areas or lines on every imaging line.

Bar collector 162 is an elongate cylindrical member which extends the length of grating 160 and is arranged relative to grating 160 so that when reference beam 118 passes through grating 160, reference beam 118 passes through the diameter of bar collector 162 to strike transparent material 164. When reference beam 118 strikes reflective material 164, a lambertion distribution of the scattering of reflective light occurs in the bar collector 162 and the light so enterning bar collector 162 remains therein and is transmitted to the end of bar collector 162 where it is sensed by sensor 166. As shown in Fig. 10, the end of bar collector 162 opposite sensor 166 carries a mirror thereon or is a mirroed surface to reflect light along the length of the collector to the sensor 166.

Sensor 166 provides an analog electrical signal on leads 170 which indicate reference beam 118 entering the bar collector 162.

In the preferred embodiment bar collector 162 has a diameter of 1.75 inches and is made of such as acrylic materials although material known under the trademark of lucite has provided good results. The narrow stripe of reflective material 164 may be any highly reflective material and in the preferred embodiment a typewritter correction fluid is used. The length of the bar collector 162 is about 24 inches to provide the desired 20 inch imaging line plus sufficient length for housekeeping and related needs.

In evaluating the glass fiber technique used herein for the bar collector 162 it was discovered by placing a strip of masking tape along the length of bar collector 162 opposite the point of entry of reference beam 118 that a significant increase in the energy transmitted by bar collector 162 was obtained. The increased energy level from the nonreflecting surface of the tape was immediately recognized to be the result of eliminating twice the area-gap index of refraction (a high loss component) while containing and reflecting the trapped energy beam. It was quickly determined that a highly reflective material such as typewritter correction fluid applied to the rod's cylindrical surface would be highly efficient in preventing the transmissive loss and aid in providing good lambertion distribution of reference beam 118 striking the same. Further investigations showed that is was necessary to coat only a stripe about 1/4 of an inch wide along the length of the rod provide more than adequate energy for the sensor 166. Best results for 24 inches long rods indicated that the best energy response was obtained by using a rod diameter of from 1.5 inches to 1.75 inches.

In the preferred embodiment the grating 160 has a three hundred line per inch optical scale to provide the signals from sensor 166 to locate the position of fine beam 60 along electrophotographic member 64.

It should be noted that it is important that the sensor 166 not look at the entire cross-section of the end of the collector tube 162, but only at a smaller area centered around the longitudinal axis of a bar collector 162. It also is important that only the single narrow stripe of reflective material 164 is on the circumference of the bar and the remainder of the circumference of the bar is otherwise clean to maximize the internal reflection of light on the bar. The leads 170 from the sensor 166 in the preferred embodiment are connected to an automatic gain control amplifier to smooth out the signal from the bar collector 162 in response to beam 118 entering the collector at different distances from the sensor. In the preferred embodiment the signal from the automatic amplifier is used in a phase locked loop to provide the desired signals indicating the location of a fine beam 62 along the imaging lines on the member 64.

It is important that the reference beam 118 present a focused image across the entire length of grating 160 so that the signals provided from sensor 166 will be well defined. If reference beam presents focused images which are off the plane of grating 160, the edges of the pulses generated from sensor 166 will not be well defined and the location of fine beam 62 along the imaging lines will not be precise.

As has been stated digital data which is input to the digital platemaker is in the form of graphics data and text data. The graphics data is used to reproduce graphic images on the electrophotographic member 64 with one black and white image or one color separation image being formed on each member.

The graphics data is in the form binary digital words with the value of each word representing a scaled areal density to be formed on an imaging area on the member. Each word is used to select a pattern of elements from a memory or other storage device which represents the scaled density equal to the value of the graphics digital word.

The patterns selected from the memory are formed on the member by discharging and leaving charged elements in an imaging area. The elements are arranged equispaced across the surface of the member and are arranged in rows and columns. Selective elements in the imaging areas are used to form the patterns and in the preferred embodiment are grouped together in irregular hexagonal picture elements or pixels. It should be remembered that the configuration of the pixels is a choice of the designer the imaging areas in which the configurations may be formed being of a predetermined number of rows and of a predetermined number of columns. One pattern then may be formed in one pixel.

The columns at which the elements are located are defined by the lines which would be formed by the individual rays or beamlets of the fine beam 62 as they are passed across an imaging line. The rows of the imaging lines are defined by sample clock signals produced from the grating system 150.

The imaging lines are comprised of two scan lines of graphics pixels with each scan line of graphics pixels being controlled by one graphics data channel. Thus graphics channel a controls the graphics pixels to be formed in scan line A, and the graphics data in channel B controls the graphics pixels to be formed in scan line B.

It bears repeating that if the text data contains no information to be formed on the electrophotographic member 64, the graphics data is formated so that the graphics image or images contained therein will be formed on the member 64 while the remainder of the surface of light 64 will be discharged. Thus the printing plate formed by such graphics and text data will print on the receptor only the graphics image or images and leave a clear background.

The text data is used to reproduce text images and line graphics such as charts and graphs on member 64. While the graphics data provides for the scale density of the imaging areas to be formed on member 64, the text data is used to provide binary imaging of image areas of the member 64 which in the preferred embodiment are the same as text pixels.

In the preferred embodiment the text pixels have a definite relationship to the graphics pixels.

In every imaging line the text pixels are aligned six abreast with the text pixels being two rows wide. Specifically, what may be called the first text pixel or scan line covers the area defined by the first four columns of individual rays by two rows deep. The next text pixel is three columns wide by the same two rows deep. The next two text pixels are each four columns wide and the same two rows deep. The next text pixel is three columns wide and the same two rows deep, and the last text pixel is four columns wide by the same two rows deep. Thus it may be said that the text pixels are arranged across the imaging line at every two rows. Every word of the text data represents the binary imaging to be formed in text pixels formed along the same two rows of the image line. For each of the six

text pixels in those two rows, there are four possible states of conditions. The first two states are defined as being the normal states, the first of which will inhibit the formation of rays of fine beam 62 to be charged areas of the member 62. These charged areas will form solid printing which will print such as black ink on a white background. The second condition is to enable the formation of individual rays of fine beam 62 as determined by the graphics data for that row. The last two states are defined as being the reverse mode, the first condition of the reverse causes a formation of rays of fine beam 62 to discharge areas of the member 64. These discharged areas will then form text images in areas otherwise formed of graphics images to provide printing plates which print clear text in graphics images. The last state of the reverse mode enables the formation of rays under control of the graphics data.

These four states are formed of the binary combination of a control bit and one data bit of every word of the text data. Thus as will be explained hereinafter, one data bit and one control bit of every word controls inhibiting of the formation of rays, enabling of formation of rays by the graphics data or causes the formation of rays in every text pixel.

If the graphics data is a nullity and is used only to clear the entire plate, then the information contained in the text data will be able to form text images only by inhibiting the formation of rays to leave charged areas which will print solid on the receptor. This is the first condition under the normal state. It will be noted that text images will not be able to be formed by the first condition of the reverse which causes the formation of rays because the graphics data is clearing the plate and there will be no background against which to form the clear text images.

If the graphics data is full density for the entire plate no rays will be formed anywhere across the plate by the graphics data. In such a case, the only text images which may be formed are under the reverse mode first condition which causes the formation of the rays to discharge areas in an undischarged field to print clear in a field of solid printing area. It will be noted that in such a case the first state or condition of the normal mode has no effect to create or form a text image by inhibiting the formation of rays because there are no rays being formed by the graphics data.

Thus the relationship between the graphics and text data may be described as one where the graphics data is able to form graphics images across the entire imaging area of the member 64 and depending upon the images so formed the text data may form text images. Moreover, the graphics data contains enough information to image across the entire imaging area of member 64 as does the text data with formation of patterns in the graphics pixels and the formation of the text pixels being entirely independent of one another. Imaging the graphics then text in this matter has advantages in that different imaging schemes for the graphics may be implemented without interfering between the relationship between the graphics and text imaging.

Referring now to drawing figures 11, 12 and 13, there is illustrated in fig. 11 a chart of three imaging lines which are formed on the electrophotoconductiv member 64. Imaging lines 1 and 2 illustrate the formation of graphics pixels while image line 3 illustrates the formation of text pixels. Image lines 1 and 2 each comprise an A-channel scan line and a B-channel scan line, there being six thousand (6,000) image positions in each of the A-channel and B-channel scan lines with the imaging positions in the B-channel scan lines being offset relative to the imaging positions in the A-channel

scan lines. Thus in each of image lines 1 and 2, there are 6,000 graphic pixels which may be formed.

Referring now to Fig. 12, there is depicted a field of graphics pixels which may be presumed to be laid out on the surface of the electrophotographic member. The pixels are irregular hexagonal areas designated GP1, GP2, GP3, GP4 and GP5 inclusive and are parts of an overall pattern of hexagons which cover the surface of member 64. Obviously the defining lines illustrated in Figs. 11, 12 and 13 are imaginary and merely represent a theoretical geometric pattern which for convenience describes the manner in which the imaging is effected.

The individual rays of fine beam 62 are going to remove charge from the graphics pixel respectively. The possibility for removal is represented in this case by elements of discharge which are generally circular and which count for the entire interior of each graphics pixel. The graphics pixels according to the invention are arranged in interleaved columns so that the field of pixels may be considered to occupy all of the area. Graphics pixels GP1, GP2 and GP3 are shown with their flat sides respectively in common at 200 and 202 while the flat sides of graphics pixels GP4 and GP5 are in common at 204. The adjoining pixels to the left and to the right of these pixels are also arranged in this way but are not illustrated. The graphics pixels in adjacent scan lines are interleaved or staggered relative to one another; hence, pixels GP4 and GP5 have their top apexes at the location of the common flat sides 200 and 202 as indicated for example at 206 and 208. This interleaving is illustrated for adjoining scan lines in fig. 11.

Graphics pixels GP1, GP2, GP4 and GP5 have centering points laid out in them which are numbered and which can be seen to be formed at the junctures of rows and

columns that are marked above and to the left of the field of pixels. The columns are defined as imaginary lines described by each of the individual rays of fine beam 62 as fine beam 62 is swept across each image line. The rows are defined along the image line by the optical grating system 150 and occur at equidistant intervals along every image line.

In the preferred embodiment, the image positions illustrated in Fig. 11 are defined as having six rows numbered 0-5 and 11 columns. Scan line A is formed of columns 1-11 while scan line B is formed of columns 12 through 22, the column numbers corresponding to the number of individual rays. While the graphic pixels GP1 through GP5 in the preferred embodiment have been defined as irregular hexagons having the number of elements illustrated, the graphic pixels may be defined as having any geometric configuration desired which fits the limitations of the six rows and eleven columns. As will be described more fully hereinafter concerning the electronics, the limitations of six rows and eleven columns is purely one of electronics such that by modifying the electronics any number of the number of columns and rows may be defined to be an imaged area and in turn any geometric configuration desired may be formed therein.

In the preferred embodiment there are 19 centering points for the elements in each graphics pixel and these are arranged in fifteen horizontal columns and six vertical rows. The columns are all confined within each graphics pixel between its top and bottom apexes. All graphics pixels are considered to be oriented exactly the same with their long flat surfaces left and right and apexes top and bottom. While the rows are formed somewhat differently. Five of the rows will have centering points that are within the confines of the graphics pixel between left and right flat sides, while the sixth row image

will never have centering points located thereon is coincident with the left and right flat sides of the graphics pixels. This is a spacing expedient to be explained later.

The centering points which have been described are the centers of the circular dischargable or formable elements such as 210 which are going to be discharged by the individual rays. As seen the circular element 210 which is the same as all others is large enough so that in addition to covering a certain area within its graphics pixel overlaps into adjoining pixel. Thus the circular element 88 not only discharges the area within the graphics pixel GP3 which it encompasses but also has a cordal slice or segment which it discharges at each of graphics pixels GP6 and GP7 as indicated at 212 and 214.

If we drew a line between each of the centering points vertically and diagonally, we would see the overall patterns of general hexagonal area which can be seen in the pixels GP1, GP2, GP4, GP5 and of course these hexagons have the appearance that they are made up of equilateral triangles. Thus the circular discharge elements such as 210 will discharge the area around its centering point comprised of the six equilateral triangle surrounding that centering point plus six more cordal segments beyond that hexagon defined by those triangles. And since every other circular element will also discharge the photoconductive surface of the electrophotographic member in the same way, the discharged circular elements which are side by side always overlap.

Graphics pixels GP3 has six of the top circular elements shown in outline at 216 and there overlapped areas are obvious. In addition, there can be seen the 8 overlapped cordal segments of discharge area that protrude into adjoining pixels including the pixels GP2 and GP7.

For explanatory purposes, the total discharged area of any graphics pixel can be approximated by the triangles which are included in the circular elements discharged. The more circular elements of discharge in a given graphics pixel equals the approximation because of the overlap within the graphics pixel. In the circular element 210 the equilateral triangles are identified as TR1 to TR6 inclusive. It is illustrated in graphics pixels GP1 and GP4 that in the horizontal columns there is only one centering point in each of columns 1, 11, 12, and 22; two centering points in each of columns 2,4,6, 8,10, 13, 15, 17, 19 and 21; and three points in each of columns, 3, 5, 7, 9, 14, 16, 18 and 20. These conditions are requirements of the electronics and may be altered by altering the electronics as is desired. In the preferred embodiment these conditions are requirements of the electronics and must be met during the laying down of the discharge elements.

The fine beam 62 which makes one pass to provide the horizontal column information for generation of the centering points for the graphics pixels which are being described in an image line will be composed of a maximum of 22 individual rays all passing over the total image line at any one time. It is assumed that all rays will be used for the graphics pixels in an image line but the maximum number of rays or beamlets that will be operating at any given time for the configuration illustrated in Fig. 12 will be 9, because as is illustrated in Fig. 12, there are no more than 9 centering points along any one row. This is shown in Fig. 12 and graphics pixels GP2 and GP4 have scan line A rows 0 and 1 and scan line B rows 4 and 5. Along scan line A row 0 and scan line B row 4 centering points 1, 2, 3 and 4 of graphics pixel 2 are defined while centering points 16, 17, 18, 19 and 20 of graphics pixel 4 are defined. Of course the minimum number of rays or beamlets operating will be zero.

Summarizing then, the horizontal columns of centering points are controlled by the number of individual rays in a fine beam 62. The rows are controlled by the information that is obtained from the optical grating system 150. The row information is used in the beam modulation electronics to discharge the desired elements as will be described hereinafter. The patterns which are imaged in the graphics pixels in response to the density values indicated by the digital words of the graphics data may be of any configuration desired to represent the equivalent density and the preferred embodiment, there is one predetermined pattern which is to be formed in the graphics pixel for every density value indicated by the graphics data.

In the preferred embodiment the distance between the center lines of scan line A and scan line B is 169.3 microns while the distance between the flat sides of each graphics pixel is 171.7 microns. The diameter at each of the discharged elements is 35 microns with all of these values being based upon a 150 line per inch resolution.

It will be noted that as there are 24 individual elements in each graphics pixel which may be either charged or discharged there are a total of 2^{24} or approximately 16 million combinations of discharge elements which are available to image the desired density patterns. Thus, even if the graphics data may only represent 256 steps of density with 8 bits of information per graphics digital word, each step of the 256 step grade scale may be represented by a plurality of the 16 million available patterns which have density values equal to or approximately equal thereto.

The text pixels which are formed in response to the text

data are illustrated in figs. 11 and 13. As shown in Fig. 11, the image line 3, there are six scan lines of text pixels per image line. The text pixels are arranged 3 wide for every graphics data scan line and are two rows deep. The arrangement of the text pixels relative to the graphics pixels and the rows and columns described hereinbefore is illustrated in figure 13.

The text pixels are arranged slightly shifted in relative to the graphics pixels, and there are about 9 text pixels per graphics pixels or graphics image area. Referring to fig. 11, along one image line there are 18,002 text pixel rows with six text pixels per row. The 18.002 rows of text pixels results by multiplying the 3,000 graphics pixel per scan line by 3 rows of text pixels per graphics pixel plus two additional rows of text pixels required to cover the area corresponding to the channel B pixels which are shifted relative to the channel A pixels.

The relationship of the text pixels to the graphics pixels in the A channel scan line and B channel scan line is illustrated in both figs. 11 and 13. The relationship of the text pixels to the columns defined by the individual rays is illustrated in fig. 13.

Fig. 13 illustrates text pixels 1-48 arranged along one image line and illustrates in dashed lines the relationship thereto of graphics pixels GP1, GP2, GP4 and GP5. The electronics of the digital platemaker system are arranged so that each word of the text data received thereby operates on 1 text pixel row of six abreast text pixels. Thus successive words of the text data operate on the rows of text pixels TP1 - TP6, TP7 - TP12 TP13 through TP14, and so on.

The text pixels are defined as being that area which incloses a certain number of discharge elements which

are formable by certain rays of the fine beam 62 across two successive graphic channel rows. By reference to Fig. 12 it will be seen that the rows indicated at the top of Fig. 13 correspond to the rows indicated at the top of Fig. 12. The areas enclosed by the text pixels with reference to the formable discharge elements are shown in Fig. 13 where text pixel 31 is formed of the area including the elements formed by rays 1, 2, 3 and 4 in the graphics A channel rows 3 and 4. Text pixel 32 is formed of the area including the elements formed by rays 5, 6 and 7 in the same rows 3 and 4. Text pixel 33 is formed of the area including the elements formed by rays 8, 9, 10 and 11 in the same rows 3 and 4. Text pixel 34 is formed of the area including the elements formed by rays 12, 13, 14 and 15 in the same rows three and 4. Text pixel 35 is formed of the area including the elements which are formed by rays 16, 17 and 18 in the same rows 3 and 4. And text pixel 36 is formed of the area including the elements formed by rays 19, 20, 21 and 22 in the same rows 3 and 4.

Every text pixel of the field of text pixels across the entire imaging area of the member 64 of which the text pixel TP1-TP48 illustrated in Fig. 13 are representative, may be operated on one of four ways as has been described hereinbefore. These four ways result from the binary combination of one information bit and one control bit of the digital words of the text data. These four states or conditions are divided into two modes, the normal mode and the reverse mode. In the normal mode the text data may inhibit the formation of rays in any text pixel, this inhibiting the formation of rays causing to leave the area of that particular text pixel charged which will be toned and will print solid upon a receptor. The second state of the normal mode is where the text data enables the formation of rays under control of the graphics data. The first state of the reverse mode causes the formation of rays in the area

of a text pixel to form a clear text image in a field of a graphics image. On the receptor then the text will be clear within the confines of the printed image. The second state of the reverse mode is where the text data enables the formation of rays under control of the graphics data to produce a graphics image represented therein.

It therefore may readily be seen that the second states of the normal and reverse mode simply allow the formation of the graphics image carried by the graphics data. That the first state of the normal mode inhibits the formation of any rays or discharge elements in the entire area of the text pixels, and the first state of the reverse mode causes the formation of rays or discharge elements in a text pixel. Thus the member 64 may be imaged with text data to obtain a resolution which is three times finer than that obtainable using the graphics pixels. Further the text and graphics data does not have to be especially formated; nor does the electronics have to be constructed or arranged to switch back and forth between the text and graphics data.

In an manner similar to the predefined positions of the discharge elements of the graphics pixels, there are predetermined centering points or positions for the discharge of elements in the text pixels. It may readily be ascertained by viewing Fig. 13 that not all of the formable elements in a text pixel may be discharged to clear the total area of a text pixel during the first state of the reverse mode, only half of the formable elements. In fact, it may observed in Fig. 13 that only half of the dischargable elements in any one text pixel need by discharged to discharge the entire area of that text pixel. This is illustrated in text pixel 43 wherein there are four discharged elements represented by the four circles 218. Thus it may be ascertained that by discharging the elements whose centering points have x

or crossed line as is illustrated text pixels TP32-TP36 the entire areas of those text pixels may be discharged. Thus it may be seen in the reverse mode, in the condition which causes the formation of rays to discharge the areas of the text pixels, only every other ray need be formed in any one row of dischargable elements, while in the next successive row only those elements which were not formed in the preceeding row need be formed. Thus in text pixel 31, rays 2 and 4 are formed in row 3 while rays 1 and 3 are formed in row 4. Thus to perform the reverse mode function which causes the formation of rays to discharge elements of the text pixel, the electronics need only form alternating rays in alternating rows. The formation of these rays in the reverse mode then may be described as text mode odd and text mode even, the odd and even referring to the desired rays which are to be formed in even numbered rows and the rays which are to be formed in the odd numbered rows. The implementation of this odd and even arrangement will be discussed more fully hereinafter in conjunction with the electronics.

The text data may be used to form solid printing areas such as alfanumerics, high receptor and further may be used to print on a receptor line graphics such as engineering drawings, charts, graphs, etc.

There are two sets of electronics or electrical systems for the digital platemaker, each electronic system being dedicated and acting in conjunction with only the left or righthand optical system. The electronics or electronics system is referred to the electronics required to receive graphics and text data and apply radio frequency signals to the acousto-optic deflector, which discharges incremental areas on the electrophotographic member 64. Both electronics systems perform the same functions and are identical to each other in all respects so that a description of one electronic system is a description

of the other electronic system, and reference to an electronic system in conjunction with the modulation of the lazar beam in a singular refers to electronic systems of the left and right hand optical systems.

The electronics system illustrated in Fig. 1 generally illustrates the operation of both the electronic systems while the electronics system illustrated in Fig. 14 is a more detailed illustration of the same.

Data is input to the electronics system on input leads 250, which are illustrated with arrows having a width to illustrate that the input data is comprised of digital words having several parallel bits conveying the desired information. In the preferred embodiment the data is input to graphics data buffers 32 and 34 and text data buffers sequentially, that is to say that buffer 32 is loaded first, buffer 34 is loaded next and then buffer 36 is loaded last. The data contained in each buffer is the information or density values required to form graphics pixels along one scan line and text pixels across an entire image line. Inputting of the data to the buffers 32, 34 and 36 may be under control of such as a central controller 252 by way of leads 254. Central controller 252 may be interfaced with whatever system that the text and graphics data are supplied from and may take form of a hard wired controller of a programmable controller as is desired. In the preferred embodiment, central controller 252 is a programmable microprocessor.

During an initialization period before the actual text and graphics data are input to the digital plate maker the patterns which are selected by the graphics data are loaded into the pattern generators 38 and 40 by way of input lead 250 under control of central controller 252. In this initialization period, data in form of the patterns which are to be loaded in the generators 38

and 40 are input into buffers 32 and 34 and carried by leads 42 and 44, leads 256 and 258 to the inputs of pattern generators 38 and 40 indicated by arrow heads 260 and 262. Thus, it may be determined that pattern generators 38 and 40 comprise memory devices which may be loaded, such devices being called random access memories or RAM. Loading of the pattern generators 38 and 40 is under control of central controller 252 by way of lead or leads 264. Suitable gating is provided which will be described hereinafter so that the graphics data carried by leads 42 and 44 to pattern generators 38 and 40 will not interfere with the patterns output by generators 38 and 40. After the initialization period has been completed and all the patterns are loaded into the pattern generators, the operational period of the imaging cycle is commenced in which the pattern generators become output devices.

Generation of the patterns is in response to graphics data applied to pattern generators 38 and 40 by way of leads 42 and 44. Control of the generation of patterns and indication of the location of fine beam 62 along the scanning line occurs by way of leads 264 from central controller 252. Central controller 252 is connected to optical grating system 150 by way of leads 256.

The output of pattern generators 38 and 40 are applied on leads 48 and 50 to beam logic 46 which also has applied thereto the text data over leads 52. Control of the beam logic including indication of the position of fine beam 62 along the scan line is from central controller 252 to beam logic 46 over leads 268.

In the beam logic the modulation of the graphics patterns to be formed by the individual rows are modulated by the text data as has been described hereinbefore with the output of the beam logic on leads 56 comprising the radio frequency signals required to produce the image

indicated by the text and graphics data. Generation of the fine beam 62 and reference beam 118 is as has been previously described and therefore need not be redescribed. It suffices to say that optical path 270 illustrated in Fig. 14 generally comprises the optical elements between the acousto-optic deflector 54 and the electrophotographic member 64. Reference beam 118 is diagrammatically illustrated as being part of fine beam 118, after fine beam 62 exists the optical path 270. This is shown for illustration purposes only.

Turning now to Fig. 15, the pattern generators 38 and 40 are more specifically shown as is the gating required to load pattern generators 38 and 40 during the initial period. Latching line driver 280 is applied with data on leads 256, which in Fig. 15 are represented by single lines for clarity of the drawing. During the initial period in which patterns are loaded into pattern generator 38, the latching line driver 280 under control of leads 282 allows the data on leads 256 to pass therethrough and be input by channel A pattern RAM 284 which is placed in the read mode by lead 286. In a like manner, data which is supplied on leads 258 are applied to latching line driver 286, which during the initial period pass the data therethrough and it is input by channel B pattern RAM 288. Channel B pattern RAM is placed in the read mode also by lead 286. At the end of the initial period and at the commencement of the operation of the imaging cycle, latching line drivers 280 and 286 have their outputs placed to a tri-state level which places no load on leads 260, 48, 262 and 50. Thus in the operational period, the data appearing on leads 48 and 50 will be only the outputs of pattern RAMS 284 and 288.

During the operational period, graphics data is supplied to pattern generators 38 and 40 by way of leads 42 and 44. The graphics data is input therefrom to channel A

latching counter 290 and channel B latching counter 292, respectively. The input of latching counters 290 and 292 is in the form of parallel words having 8 bits of information each. The output of latching counters 290 and 292 are 11 bits of information, the 8 most significant bits of the output being the same as the graphics data input thereto and the three least significant bits being generated in response to signals from the optical grating system. Loading of latching counters 290 and 292 is by way of a load lead 294.

To understand the selection of the patterns from the pattern RAMs 284 and 288, it must be understood that the value carried by each graphics data word represents a scaled density of an incremental area which is to be produced or reproduced on member 64. It further will be remembered as is illustrated in Figs. 12 and 13, the graphics pixels have a pattern produced in five sequential rows, the sixth row being used to space between graphics pixels. Thus to form one pattern in a graphics pixel, information must be applied to the acousto-optic deflector one row at a time to form the individual rays or beamlets required to discharge the elemental areas and produce the pattern indicated by the pattern RAMS 284 and 288. In the preferred embodiment, this generation of the patterns across the five rows of the graphics pixels occurs by using the value of the graphics words to select a group of addresses in the pattern RAMS and 288. Then a row clock signal produced from the signals produced by the optical grating system 150 is used to clock or step through the selected group of addresses. The outputs of the pattern RAMS 284 and 288 at each step of the group of addresses then are the binary indications of whether an individual ray is to be formed or not. Simply stated, the graphics words are used to select a group of memory locations while a row clock is used to step through the locations. The output of the memory step by step is the information needed to turn on or off

the individual rays in fine beam 62.

Thus the clocks for latching counters 290 and 292 are applied on leads 296 and 298. The outputs of the pattern RAMS 284 and 288 are eleven bits of information each which are used to form the 22 individual rays.

The inputs to latching counters 290 and 292 are indicated as graphics data bits GD1-GD8. The outputs of latching counters 290 and 292 and the inputs to pattern RAMS 284 and 288 respectively are indicated as A-channel address leads AA0 through AA10 and B channel address leads BA0 through BA10. The output of pattern RAMs 284 and 288 are indicated as being pattern bits PB1 through PB11 and PB12 through PB22.

Concerning the stepping through the groups of memory location, it will be observed that three input bits 300 and 302 respectively of latching counters 290 and 292 are tied to ground. Thus when counters 290 and 292 are loaded by way of the signal on lead 294, the outputs AA0 to AA2 and BA0 to BA2 are at zero logic levels. Thus when clock signals are applied on leads 296 and 298, latching counters 290 and 292 respectively count up in binary manner from 0. Referring back to Figs. 11, 12 and 13, it will be noted that the rows are numbered accordingly as binary numbers from 0 to 5, which correspond respectively to the counts produced at the outputs of latching counters 290 and 292. It should further be noted that the rows for the A and B channels of graphics data are shifted relative to one another to form the desired irregular hexagons having apexes interleaved between one another. It therefore should be understood that the clocking of the channel A latching counter 290 commences earlier than the clocking of the channel B latching counter 292 to provide the patterns from the respective RAMS at the proper times.

The leads 282, 286, 294, 296 and 298 used to control the functions of the latching line drivers and pattern generators generally are the leads 264 indicated earlier in Fig. 14 coming from central controller 252.

In Fig. 16, there is illustrated in more detail the beam logic 46. In Fig. 16, pattern bits 1-22 are illustrated as being applied to a 22 bit one of four multiplexer 304 on one lead which is indicated as being 48 and 50. This is for clarity of the drawing. While multiplexer 304 is indicated as being one unit, which is able to select between one of four inputs, in the preferred embodiment multiplexer 304 is a plurality of multiplexers which may be individually or jointly operated upon. Beam logic 46 further comprises three switch arrays 306, 308 and 310, each of which supplies 22 individual leads of logic signals with each of the logic signals being controlled by a resistor switch network such as is illustrated in each block representing the switch arrays. Basically the network consists of the output lead being tied to a plus-5 volt source through a 1-K resistor, there being a programmable switch which may be closed to short the output lead to ground. When the switch is open, the logic level of the outputs of the switch arrays are at a logic of 1; while when the switches are closed the outputs are at logic state zero.

Array 306 is labelled as being the text reverse even switch array indicating that the outputs of this array indicate which of the individual rays are to be formed during a reverse mode even row indicated by the text data. The array 308 is labelled as being a text reverse odd switch array, the label indicating that the outputs of this array indicate the individual rays which are to be formed during a reverse mode odd row condition indicated by the text data. Array 310 is labelled as being a text normal switch array with its outputs indicating the rays which are to be inhibited. The outputs of each

array, TRE1-TRE22, TRO1-TRO22 and TN1-TN22 are applied to the inputs multiplexer 304 over leads 306, 308 and 310 respectively.

Text data represented by text data bits TD1-TD8 at 312 of Fig. 16 are applied through a gating 314 to the A and B select inputs of multiplexer 304 on leads 316 and 318. Also applied to gating 314 is address lead AA0 from the A channel latching counter 290.

The outputs of multiplexer 304 are indicated as being ray data RD1-RD22, each output corresponding to the formation of an individual ray of fine beam 62 and acousto-optic deflector 54 from beam 60. The outputs of multiplexer 304 pass on lead 320 to a 22 bit latch 322, which holds the output data in response to a latch signal on lead 324. The output of the 22 bit latch is applied through leads 326 to 22 individual bit drivers 328, there being one individual bit driver for each of the output bits RD1 through RD22. The 22 bit drivers are enabled by a signal on lead 330 and provide their outputs by way of leads 332 to 22 RF oscillators 334, there being one RF or radio frequency oscillator for each of the signals from bit drivers 328 and the outputs of the 22 RF oscillators 334 appearing on leads 56 and being applied to acousto-optic deflector 54.

In operation of the beam logic circuit, instead of there being a straight forward gating of the pattern bits PB1-PB22 by the bits of the text data TD1-TD8, the bits of the text data are used to select for each of the groups of individual rays indicated in Fig. 13 between the four inputs to multiplexer 304, pattern bits, reverse mode even bits, reverse mode odd bits, and normal mode bits. But to this extent the illustration of multiplexer 304 in Fig. 16, as selecting between one of the four inputs for all of the ray data bits is somewhat misleading.

A better illustration of the multiplexing which occurs is illustrated in Fig. 18 with Fig. 17 illustrating in chart form which bits of the text data are used to modulate the individual rays. In Fig. 18, there is illustrated one of four multiplexer 336 having four groups of input bits, one group for each of the ray data bits output therefrom. As may be seen in Fig. 17, text data 1 is used to operate on or select the proper output for rays 1-4. Thus the outputs of one of four multiplexer 336 are indicated as being the ray data bits RD1 through RD4, these of course being the logic signals which determine whether or not rays 1-4 are formed or not. Thus to produce ray data bit R1, multiplexer 336 may select one of pattern bit1, text reverse even bit 1, text reverse odd bit 1 and text normal bit 1. Multiplexer 336 may make a light selection for each of ray data bits RD2-RD4. It should be remembered that when the ray data bits are such as a logic of 1, they indicate that an individual ray should be formed in fine beam 62 while when the ray data bits are at a logic of zero (0), they indicate that no individual ray should be formed in fine beam 62.

Concerning gating 314 which is illustrated more fully in Fig. 18, it should be rememberd that binary combination of a control bit which is shown in Fig. 17 to be the text data bit TD7 and an information bit such as text data bit TD1 which are used to select between the four states. Gating circuit 314 provides for this in addition for providing for the turning on of the desired individual rays during a reverse mode and the even and odd rows.

To this end, it will be noted that a signal which is a logic level 1 indicating that the beam logic is out of the text mode is applied to norgate 340 to lead 342, that the output thereof is a logic of zero (0) which is applied to AND gates 344 and 346 on lead 340 respectively. The outputs of AND gates 344 and 346 thus may only

be a logic of zero (0) which would apply to the A and B outputs of multiplexer 336 selects the pattern bits to be output as the ray data bits RD1-RD4. The same thing occurs when the T1 input to norgate 340 is a logic of 1, indicating that the pattern bits generated by the graphics data are to be formed in the text pixel or pixels corresponding to rays R1-R4. When the text mode signal is a logic of zero (0) and the TD1 is a logic of 0 (zero), then the output of Norgate 3-4 is a logic of 1, which enables AND gate 344 and 346 to provide signal which will select other than the graphics data to be formed in text pixels corresponding to rays R1-R4.

In such a case, if signal TD7 is a logic of 1, indicating a normal mode, then the outputs of norgates 350 and 352 also will be a logic of 1, which is applied respectively by way of leads 354 and 356 to AND gates 344 and 346. The outputs of AND gates 344 and 346 then will both be logic of 1, which will select as the ray data bits RD1-RD4 the logical levels appearing on the signals labelled TN1-TN4 or text normal. The outputs from the text normal switch array 310 illustrated in Fig. 16 thus must be programmed in logical zeros (0's) so that the formation of individual rays R1-R4 is inhibited. It may be stated at this time that switch arrays 306, 308, 310 are provided in the preferred embodiment to provide versatility of the apparatus.

Further in the case where the signals on lead 342 and the logic level of bit TD1, the logical zeroes, if the TD7 signal is a logical zero indicating the reverse mode, then the outputs of Norgates 350 and 352 will be controlled by the logical level input thereto by the A channel address bit zero, A-A zero. It will be understood that this signal A-A zero is continuously being oscillated between a logic of zero and a logic of 1 state, as the fine beam 62 is passed across the surface of the electrophotographic member 64. Thus when bit TD7 is a logical

zero, the output of Or gate 350 is directly controlled by the logical level of signal A-A zero, while the output of Or gate 52 is the inverse thereof due to inverter 358. Thus for an even row, the outputs provided by AND gates 344 and 346 will be such that multiplexer 336 outputs as ray data bits RD1-RD4 the logical levels appearing at the signals TRE1 through TRE4. At an odd number row, logic levels output by multiplexer 336 as ray data bits RD1-RD4 will be the logical levels input thereto by signals TRO1-TRO4.

It will be appreciated that the one of four multiplexer used to form the ray data bit RD1-RD4 is an example of the multiplexer circuit used to provide the ray data bits for each of the groups of rays illustrated in connection with the text pixels of Fig. 13. The gating circuit 314 also is the same for each of those multiplexer circuits with only the information bit TD1 being changed for the groups of rays to the corresponding text data bit.

After the electro-photographic member 64 has been charged at charging station 70 and has been imaged with fine beam 62, the latent image carried thereon is toned at toning station 72, which is a portion of the vertical toning system of the digital platemaker.

The vertical toning system may best be understood by considering that its purpose is to apply toner (carrier fluid having suspending therein toner particles) to the electro-photographic member 64. The areas of member 64 which remain charged after imaging are the areas which accept the toning particles. The toned member thereafter has the toned particles fused to the member for use as a printing plate in such as a lithographic printing press, but this fusing step occurring otherwise than in the digital platemaker

The toner which is supplied to the electrophotographic

member is in the form of a carrier fluid known as "ISOPAR", which is a registered trademark of the Exxon Corporation. The carrier fluid carrying finely ground particles of resinous material which may be positively or negatively charged and in the preferred embodiment herein the particles are positively charged. Hereinafter, the term "toner fluid" will refer to this carrier fluid containing the resinous toner particles, while the term "carrier fluid" will refer only to the "ISOPAR" without the resinous particles.

As has been stated, the member 64 is mounted on drum 66 and is rotated thereby past charging station 70, imaging plane represented by the fine beam 62 and the toning station 62, at which the toner fluid is applied to the member.

It will be noted that electrophotographic member 64 comprises a substrate carrying a photoconductive coating, the substrate in the preferred embodiment being a magnetic material such as stainless steel and the electrophotoconductive coating being the coating disclosed and claimed in U.S. Patent 4,025,399, which has been incorporated herein by reference. The member is held in the drum by magnetic strips embedded at the outer circumference of the drum, of course, other hold-down systems such as vacuum systems could be used to maintain the member in fixed relationship to the outer circumference of the drum. These other systems could further include clamps, springs, etc.

As the member rotates past the toning station 72, there is first applied thereto a quantity of carrier fluid which wets the surface of the member for purposes which will be described hereinafter. This wetting of the surface occurs at what may be called an upper chamber of the toning station 72. Thereafter, the toner fluid is applied to the member into phases which may be referred to as the

initialization phase and the operational phase. During the initialization phase, a meniscus of toner fluid is established between toning station 72 and member 64, while during the operational phase, the meniscus is maintained between the toning station 72 and the member. It should be noted, as illustrated in Fig. 1, toning station 72 is essentially verticle along the circumference of drum 66, and thereby the meniscus established between toning station 72 and member 64 is essentially vertical.

Turning now to Fig. 19, there is shown in block diagram form the toning system which is indicated generally by the reference character 400. The toning station 72 illustrated in the earlier drawings comprises left and right hand shoes 402 and 404, respectively. It is the shoes which are used to apply the toner fluid to the member 64, and it is between the shoes and the member 64 then the vertical meniscus is established and maintained. As may be readily understood, the left-hand shoe 402 is used in conjunction with the left hand optical system 82, while the right hand shoe 404 is used in conjunction with the right hand optical system 84. It will be understood that an explanation of the toning system for the right-hand optical system is an explanation of the toning system for the left-hand optical system, the toning systems for both sides being more images or exactly the same for both sides. Thus Fig. 19 is a block diagram of both the left and right hand toning systems, although only one set of elements is illustrated.

During the initialization phase, carrier fluid is supplied from reservoir system 406 to the right hand shoe 404 by way of tubing 408 under action of pump 410. Pump 410 operates in response to or under control of controller 412 by way of lead 414. Toner fluid is carried to right hand shoe 404 from the pressure system 416 by way of tubing 418 under control of pump 420, pump 420 being controlled in

turn by controller 412 by leads 422. Excess toner fluid is returned to pressure system 416 from right hand shoe 404 by way of tubing 424.

Used toner fluid is carried to sump system 426 by way of tubing 428, sump system 426 being at a vacuum or having a vacuum with which to remove the used toner fluid from the member. Used toner fluid contained in sump system 426 may be returned to the reservoir system 406 by way of tubing 430 by action of pump 432, pump 432 in turn being controlled by controller 412 by way of leads 444.

After the meniscus has been established during the initialization phase, valve 436 is used to admit air into pressure system 416 over tubing 438 to aid in the maintanance of the meniscus between the shoe 404 and the member 64.

It is important that the application of the carrier and toner fluids and the operation of the vacuum sump system occur at the proper time intervals as the member 64 is rotated past the shoe 404 and to obtain the timing information and sensor 440 is coupled to drum 66 and supplies the timing information to controller 412 by way of leads 444.

The toning station 72 is generally illustrated in Fig. 20 wherein left and right hand shoes 402 and 404 are carried by backplate 440. The back plate 440 carries four rollers, 442, two at each end which are in rolling contact with drum 66 along surfaces 444. Rollers 442 are adjustable by way of a cam mounting to adjust the spacing between shoes 402, 404, and drum 66. The spacing required between the shoes 402, 404 and drum 66 must be sufficient for the electrophotographic members 64 to pass there between and there must be additional spacing to provide for the meniscus of toner fluid established therebetween.

Toning station 72 has two positions, one being with the rollers engaged against the surfaces 444 of drum 66 during an imaging and toning cycle, and the other position being spaced from the drum and at a level below the drum in a non-toning position. A neumatic of hydraulic cylinder 446 is provided to move the toning station 72 between these two positions and further is used to provide the toning station 72 between these two positions, and further is used to provide a slight bias to maintain rollers 442 in contact with surfaces 444. Rollers 442 are engaged against surfaces 444 at the two longitudinal ends of drum 66 so as not to interfere with member 64 which is carried on drum 66 therebetween. Of course any surfaces as may be desired may be provided upon which the rollers of plate 440 may ride.

Right hand shoe 404 has as is illustrated in Fig. 21, is essentially a rectangular solid with a surface 446 which is to be placed adjacent the drum 66, having a portion 448 which is concave. The radius of this concave portion 448 is essentially equal to the radius of the drum 66 so that the concave portion 448 may be spaced equidistant from drum 66 across the entire area of the concave portion 448.

A seal member 450 is mounted on shoe 404 at the concave portion 448. This seal member 450 generally has the shape of a H with the cross-bar of H being biased towards the top of the seal. The seal is made from a resilient material such as polyurethane and is mounted into slots extending into the shoe. The seal is constructed so that when the shoe 404 is in the toning position, the edges of the seal 450 extending furthest from the shoe are engaged against the outer surface of the electro-photographic member 64.

The cross-bar 452 of the seal 450 separates the concave portion 448 into upper and lower portions 454 and 456.

In the upper portion 454, clear carrier fluid is applied to the member 64 for several reasons. These include precoating or wetting the member 64 with this wetting acting as a barrier against toner particles which are not charged to reduce fogging of the latent image and further provides a lubricant for the seal 450 to reduce wear of the seal, improve the sealing characteristics thereof and reduce the power which would otherwise be required to be supplied by motor 90 to drive the drum 66.

Cross-bar 52 is constructed to provide a wiper blade portion 458 which allows only a microscopic coating of the carrier fluid to be applied to the member 64 as it passes thereby. Of course, the wiper blade portion 458 as it is wiped across the member 64 does not disturb the quality or characteristics of the latent image carried thereon. It will further be appreciated that the carrier fluid also does not affect the quality of characteristics of the latent image on member 64.

The upper portion 454 comprises an upper chamber 460 extending into shoe 404 and opening to concave surface 448. Supply ports 462 are arranged spaced from one another along the inner wall of a upper chamber 460 supply carrier fluid transported by tubing 408 from reservoir system 406, which is supplied thereto for application to the member 64. A baffle 464 shown in Fig. 22 is contained in upper chamber 460 so that carrier fluid from ports 462 may be evenly supplied to member 64 across the length of chamber 460.

The lower portion 456 of the concave portion 448 is the portion where toner fluid is applied to member 64. A lower chamber 466 extends into shoe 404 and opens to concave portion 448. Chamber 466 extends essentially the length of the shoe. It will be noted that the cross-bar 452 essentially is the dividing between divides

the upper and lower portions 454 and 456. Toner fluid is applied to lower chamber 466 by the way of inlet ports 468, spaced along the length of chamber 466 with the toner fluid being supplied from pressure system 416 by way of tubing 418. A baffle 470 may be provided in lower chamber 466 to evenly supply toner fluid to member 64 from the individual inlet ports 468.

From lower chamber 466, toner fluid may flow down in the direction indicated by arrow 472 along concave portion 448 to vacuum slot 474.

A vacuum slot 474, a reduction in atmospheric pressure of vacuum is created by sump system 426 by way of tubing 428. This vacuum operates to remove toner fluid from both member 64 and shoe 404 as the toner fluid flows down along the concave portion 448. From vacuum slot 474, toner fluid is carried to sump system 426 by tubing 428.

It should be noted then there are outlet ports 474 spaced along the length of lower chamber 466 and against the inner wall thereof, as is illustrated in Fig. 22. These outlet ports 474 provide for return of excess toner fluid by way of tubing 424 to pressure system 416. It also should be noted that the vacuum provided by sump system 426 may be formed by any means desired.

Fig. 22 generally illustrates the angular relationship between charging station 70, the incidence of fine beam 62 on member 64, and the position of shoe 404. In the preferred embodiment, the angle between the center line of charging station 70 and fine beam 62 is 25°. The angle between fine beam 62 and the center line of shoe 404 is 30°. While these angles are indicative of the preferred embodiment, it is desired to reduce these angles to be as small as possible so that there is a minimum time between the charging of the member 64 and the toning of the latent image on member 64.

It may be seen in Fig. 22 that charging station 70 comprises a charging wire 480 with a guard 482 forming a threesided channel which is open towards drum towards drum 66. Wire 480 of course extends along the length of drum 66 as does guard 482. In the preferred embodiment, wire 480 carries a negative voltage and cover, 482 may be made of conductive material and forms an electrostatic mirror.

Circle 484 along the interface between drum 66 and 244 is shown enlarged in Fig. 23 to illustrate the relative positions between drum 66, electrophotographic member 64, toner fluid 486 and shoe 404. The relative thicknesses of the elements are expanded in Fig. 23 for illustration purposes.

The operation of the toning system may best be understood by considering that as has been stated there are phases to its operation. The first phase is known as the initial phase, and during this phase, the toner system establishes a meniscus of toner fluid between shoe 404 and member 64. During the operation phase this meniscus is maintained between member 64 and shoe 404, and is allowed to flow in the direction indicated by arrow 472 at a controlled rate essentially equal to the angular rotation of the drum. Thus as member 64 is moved past chamber 466, it supplies toner fluid to the meniscus. A quantity of toner fluid is applied against member 64 and remains stationary relative to member 64, until it is removed as vacuum slot 474. Thus, there is a minimum amount of sheer between the meniscus and member 64 which provides for suitable toning of the latent image with the toning particles.

At this point, it will be discussed how the pre-wetting reduces the fogging of the latent image. The toner fluid, as has been said, contains particles of resinous material. These particles are very sticky in that they will readily

adhere to most any surface they are brought into contact. Now when the toner fluid is manufactured, these particles are given in this case, a positive charge so that they will be attracted only to the areas which retain their negative charge from charging station 70. Not all of these particles however remain charged by the time they are used in the toning system herein.

When the toning fluid is used in the toning system, the charged particles readily are attracted to the oppositely charged areas of the latent image carried by member 64. The non-charged particles however are not so attracted and will stick to any surface to which they may come into contact with. By pre-wetting the surface of member 64, a barrier is formed through which these non-charged particles generally will not pass. Although this pre-wetting is referred to as a barrier the action which is involved is more along the lines of the non-charged particles not passing through the pre-wet because there is no force which will drive them through the pre-wet.

During the initial phase of the toning cycle toner fluid is applied to the lower chamber 466 and falls essentially by means of gravity into the space established between concave portion 448 and member 64. The rate at which toner fluid is supplied to chamber 466 is much greater than the rate at which toner fluid may flow between concave surface 448 and member 64 with excess toner fluid being returned to the pressure system 416 through the outlet ports 476 by way of tubing 424. Pressure system 416 is sealed from the atmosphere and as toner fluid is removed from the pressure system by way of the meniscus which is formed between concave surface 448 and member 64, a negative pressure is formed in the pressure tank. When this negative pressure reaches a magnitude of from two to three inches of water, the toner fluid ceases to flow between the concave surface and the member 64. Air control valve 436 which is preset to allow a controlled and

predetermined amount of air into the closed pressure system 416, then controls the flow rate of the toner fluid in the meniscus between the concave surface 448 and member 64.

If the air flow control valve 446 were to be closed, the meniscus would essentially remain stationary in the vertical position discounting of course losses from the lower edge thereof occurring from gravity and from the vacuum slot 474. As the air flow control valve 436 is opened, the rate of flow of toner fluid through the vertical meniscus increases. The establishment of this negative pressure in the pressure system 410 and the simultaneous establishment of the meniscus between concave portion 448 and member 64 is what has been defined to be the initial phase. Once the initial phase is completed, operation of the toning occurs through what has been described the operation phase. It should be understood that there are not two separate phases which are in operation of the toning system, but rather two phases which are used to describe the operation of the toning system.

The rate at which air is allowed into the pressure system 416 throug control valve 436 is predetermined so that the flow-rate of toner fluid therebetween occurs at the same speed as the angular rate of rotation of drum 66. Thus the toner fluid flows essentially stationary to the member 64. As the lower edge of the meniscus approaches the vacuum slot 474, toner fluid less the toner particles attracted to the member 64 by the latent image is removed from the member 64 with the described atmospheric vacuum.

In summary, the vertical toning system provides a meniscus of toning fluid which is essentially vertical and which is essentially stationary relative to the movement for the electrophotographic member 64 to provide toning of the latent image on the member 64. Control of the flow

of the meniscus relative to the member may be easily controlled through a suitable air control valve 436 and the toner fluid is applied to member 64 after a period of time which is relatively short after imaging of the member has occurred.

It will be noted that clear carrier fluid is indicated in upper chamber 460 by reference character 490, while toner fluid is indicated in the lower chamber 466 by reference character 46.

In the preferred embodiment, the meniscus has a thickness or the concave portion 48 as spaced from member 64 a distance of about 13/1000 of an inch. Shoe 404 may be made of any material which is nonreactive to the "ISOPAR" carrier fluid, such as aluminum or stainless steel. It further should be noted that when the toning station 72 is removed from being adjacent drum 66 to the non-toning position, the vacuum which is created at vacuum slot 474 is increased to clear off both the shoe and the member.

It is important that the commencement of the flowing of the carrier fluid and toner fluid to the shoe occurs at the proper time in relationship to the movement of the member 64 across the shoe 404. If these fluids are applied to the shoe too early, they are not contained within the seals provided by seal member 450 and may cause a mess while if the fluids are applied too late, the seals may stick to the member 64.

Referring back to the description of the electronics, one method of forming the graphic pattern in pattern generators 38 and 40 is described and claimed in a copending application Serial No. 11,320 filed February 13, 1979 and entitled DIGITAL LASER PLATEMAKER AND METHOD, the applicant being Lysle D. Cahill which application is incorporated herein by reference.

Referring back to the two toner shoes 402 and 404, it is entirely possible that one toning shoe could be used in place of the two shoes.

Modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the apended claims the invention bay be practiced otherwise than is specifically described. What is claimed and desired to be secured by Letters Patent of the United States is:

CLAIMS:

1. A method of imaging an electrophotographic member with an array of discharged elements of the surface of the member of such configuration and placement as to enable the member to be used for reproducing graphics and text images upon a receptor by printing or the like in which discharged elements individual to the graphics and discharged images individual to the text images are continuously produced intermixed, said method comprising:

A. acquiring graphics data in the form of a series of graphics digital words from a source of such words representative collectively of the graphics image, each word corresponding to a predetermined scaled density of an incremental area of the graphics image;

B. acquiring text data in the form of a series of text digital words comprised of bits from a source of such words representative collectively of the text image, each word corresponding to a group of predetermined binary densities of a plurality of area of the text image;

C. charging an electrophotographic member upon which the graphic and text images are to be reproduced in the form of discharged elements;

D. providing a fine beam of radiant energy consisting of a group of individual rays and directing the beam against the electrophotographic member to cause discharge of elements thereof, each ray being capable of discharging a single element if not extinguished when impinging against the member;

E. moving the beam and the electrophotographic member with respect to one another in accordance with an arrangement to scan the surface and adapted to have discharged elements in rows and columns on said surface wherever said rays not extinguished have impinged,

F. said fine beam being modulated as to its rays during the relative movement in the following manner:

i. generating control signals from the text digital words,

ii. generating graphics pattern density signals representative of respective different graphics digital words,

iii. modulating the rays with said pattern signals and

iv. controlling the said modulating by the control signals from the text digital words,

whereby independent graphics and text latent images may be laid down upon said electrophotographic member surface in one scanning thereof by said fine beam.

2. An apparatus for imaging an electrophotographic member with an array of discharged elements of the surface of the member of such configuration and placement so as to enable the member to be used for reproducing graphics and text images upon a receptor by printing or the like in which discharged elements individual to the graphics and discharged images individual to the text images are continuously produced intermixed, said apparatus comprising:

graphics buffer means for receiving graphics data in the form of a series of graphics digital words from a source of such words representative collectively of the graphics image, each word corresponding to a predetermined scale density of an incremental area of the graphics image;

text buffer means in the form for receiving text data in the form of a series of text digital words comprised of bits from a source of such words representative collectively of the text image, each word corresponding to a group of predetermined binary densities of a plurality of area of the text image;

pattern generator means receiving in seriatum the graphics data one digital word at a time for generating a response thereto, graphics pattern density signals representative of respective different graphics digital words;

beam logic means for producing beam logic control signals in response to said graphics pattern density signals, the beam logic means also receiving the text digital words in modulating the graphics pattern density signals in response thereto to form the beam control signals;

means for providing a fine beam of radiant energy consisting of a group of individual rays and directing the beam against the electrophotographic member to cause discharge of elements thereof, each ray being capable of discharging a single element if not extinguished when impinging against the member;

and modulating the rays with said beam modulation signals whereby independent graphics and text latent images may be laid down upon said electrophotographic member surface and one scanning thereof by fine beam.

3. A method of imaging an electrophotographic member with an array of discharged elements of such configuration and placement to enable the member to be used for producing graphics and text images upon a receptor by printing, said method comprising:

A. acquiring graphics data in the form of a series of graphics digital words from a source of such words representative of the graphics image, each word corresponding to a predetermined scaled density of an incremental area of the graphics image;

B. acquiring text data in the form of a series of text digital words comprised of bits, from a source of such words representative of the text image, each word corresponding to a group of

predetermined binary densities of a plurality of areas of the text image;

C. providing a beam of radiant energy;

D. charging an electrophotographic member upon which the graphic and text images are to be reproduced;

E. discharging the electrophotographic member selectively by a fine beam of radiant energy from the beam of radiant energy which forms graphic pixels and text pixels over the area of the member, the member and fine beam being moved relative to one another in a predetermined pattern of movement, said fine beam generally being a composite of a plurality of individual rays but at times being as little as a single ray;

F. generating sample signals which are indicative of the relative movement;

G. providing a store of area weighted graphics patterns, each graphics pattern being individual to a predetermined scaled density of a graphics pixel which is to be reproduced upon the member;

H. applying the graphics digital words and the sample signals simultaneously to the store, each graphics word being applied while a sequentially produced group of a first particular number of the sample signals is applied , the graphics words each being effective to select a group of signals representative of a particular graphics pattern which will result in the graphics pixel upon the application of the rays;

I. the sample signals being effective to control the rows in the graphics pixel where there will be discharged elements to form the pattern within the graphics pixel and the areaweighted pattern chosen by the graphics word being effective to control the columns of the graphics pixel where there will be discharged elements to form the

pattern;

J. the output from the store comprising, for each graphics word and each row chosen, a plurality of graphics beam modulating signals describing the discharge elements for the graphics pixel,

K. providing an array of binary text patterns, each text pattern being individual to a binary density of a text pixel which is to be reproduced upon the member and the output of the array comprising a plurality of constant text beam modulating signals describing the discharge elements for every row of the text pixels;

L. applying the graphics and text beam modulating signals, the text digital words and the sample signals simultaneously to a multiplexer, each text word being applied while a sequentially produced group of second particular number of the sample signals is applied, the text beam modulating signals being constantly applied, the graphics beam modulating signals being sequentially applied as theyare output from the store, and the bits of the text words being effective to select in groups of beam modulating signals for each row, one of the graphics and text beam modulating signals to be output from the multiplexer as output beam modulating signals;

M. splitting the beam of radiant energy into the plurality of rays in response to the output beam modulating signals and directing the rays as the fine beam against the electrophotographic member to form the graphics and text pixels on the member, and

N. effecting the formation of graphics and text pixels on the member for all the digital words of the graphics and text data.

1 4. An optical system for use in imaging at a scan line an electrophotographic member which is charged to form a latent image of charged and discharged areas the member thereafter being used as a printing plate, the optical system including:

means for supplying a beam of radiant energy;

splitter means for splitting from the beam a reference beam of radiant energy;

modulator means for deflecting individual rays from the beam of radiant energy in response to electrical signals applied thereto, the individual rays forming a fine beam;

alignment means for aligning the fine beam and reference beam vertically, one above the other;

Locus means providing as objects of the reference and scanning beam,

lens means arranged centered with the latent image to be formed on the member and perpendicular to the scan line;

mirror means which is rotatable for reflecting the reference and scanning beams which pass through the lens means back through the lens means and onto the member along the scan line;

deflection means for deflecting the reference beam and scanning beam through the lens means along a path centered with the member but at a level below the scan line;

the lens means providing field flattening of the reference and scanning beams passed therethrough and back again by the mirror means to maintain a focused image on the member along a scan line in response to the objects, and the scanning beam being reflected by the mirror means along the scan line with the reference beam being reflected above the scan line.

5. A field flattening lens for use in an optical imaging system wherein a beam of radiant energy is passed through the lens and back through the lens by a mirror which deflects the beam across a scan line, the lens comprising:

a plurality of lens groups comprising from the object to the image end a first positive group having a concave object side surface, a second positive group having a concave object side surface, a third positive group having a flat object side surface, and a fourth group having a flat concave side surface to provide field flattening of the beam of radiant energy along the scan line.

6. The lens as claimed in claim 5 defined substantially by the following data, where the elements L1, L2, L3 and L4 comprise respectively the first, second, third and fourth groupings:

LENS		Radius	Axial Distance Between Surfaces (mm)	N_d	V_d
	R1	-161.744			
L1			15.00	1.617	36.6
	R2	00			
			6.97		
	R3	-216.311			
L2			28.871	1.523	58.6
	R4	-213.119			
			0.20		
	R5	-2575.204			
L3			18.06	1.523	58.6
	R6	-264.288			
			0.20		
	R7	00			
L4			13.00	1.523	58.6
	R6	-265.847			

where L1-L4 are lens elements from the object to the image end, R1-R8 are the radii of the surfaces of the lens elements,

N_d is the index of refraction, V_d is the Abbe number of elements L1 through L4.

7. For use in an optical grating system, in which a beam of radiant energy is scanned in along a plane across an elongate grating of alternating opaque and transparent spaces, and the radiant energy being transmitted through the transparent spaces, a collector for collecting the radiant energy transmitted by the grating across the length of the grating and applying the collected radiant energy to a sensor, the collector comprising:

an elongate, cylindrical bar made of transparent material arranged with its center in the plane scanned by the beam and carrying a narrow stripe of reflective material in a line in the plane scanned by the beam, the remainder of the circumference of the bar being clean and smooth,

and the sensor being arranged at one of the flat ends of the bar but sensing only a portion of that end centered around the center of the bar so that radiant energy transmitted through the grating passes through the diameter of the bar to strike the reflective material and cause a Lambertian reflection of the radiant energy to direct the radiant energy to the sensor.

8. A method of toning with a toning fluid an electrophotographic member carrying a latent image of charged and discharged areas, the method comprising:

providing a chamber adjoining at least a portion of the member carrying the latent image, the chamber being defined by the member, an essentially vertical wall spaced from and parallel to the member, and a seal carried by the vertical wall and engaging against the member, the seal extending around opposite ends and the top of the chamber so that the chamber is essentially sealed to the atmosphere and so that the chamber is open to the bottom and is essentially vertically aligned;

providing a supply system which is sealed to the atmosphere containing a quality of toning fluid and able to supply toning fluid to the top of the chamber opposite the bottom opening of the chamber the supply system including a controllable valve through which atmosphere may be admitted to the system;

moving the member relative to the chamber in a downward direction at a predetermined speed with the seals maintaining the chamber essentially sealed to the atmosphere;

supplying toning fluid to the top of the chamber from the supply system, the toning fluid moving from the top of the chamber to the bottom of the chamber under the force of gravity, the toning fluid which is moving down through the chamber and thereby being removed from the supply system causing a negative atmospheric pressure is the supply system and when the negative pressure in the supply system equals the weight of the toning fluid moving down through the chamber, the toning fluid being held stationary and in equilibrium in an essentially vertical meniscus filling essentially the volume of the chamber;

admitting atmosphere to the supply system at a controllable rate to reduce the negative pressure in the supply system so that the toning fluid may move down through the chamber; and

controlling the rate of atmosphere being admitted to the supply system so that the speed of movement of the toning fluid in the chamber is essentially equal to the speed of movement of the member, thereby the toning fluid remaining essentially stationary relative to the member so that the toning fluid may tone the latent image carried on the member.

9. Apparatus for toning with a toning fluid an electrophotographic member carrying a latent image of charged and discharged areas the method comprising:

shoe means adjoining at least a portion of the member carrying the latent image, the shoe means providing an essentially vertical wall spaced from and parallel to the member,

a seal carried by the vertical wall and extending outward therefrom to engage against the member on three sides, the member, the seal and the vertical wall defining a downwardly opening chamber essentially sealed to the atmosphere except at the bottom opening with the chamber being essentially vertically aligned,

supply means coupled to the shoe at the top of the chamber, the supply means being otherwise sealed to the atmosphere except to the opening to the top of the chamber and containing a quantity of toning fluid which is able to supply to the top of the chamber, the supply means including a controllable valve through which atmosphere may be admitted to the system;

means for moving the member relative to the chamber in a downward direction in a predetermined speed with the seals maintaining the chamber essentially sealed to the atmosphere;

pump means for supplying toning fluid to the top of the chamber from the supply system, the toning fluid moving from the top of the chamber to the bottom of the chamber under the force of gravity, the toning fluid which is moving down through the chamber as thereby being removed from the supply system causing a negative atmospheric pressure in the supply system, and when the negative pressure in the supply system equals the weight of the toning fluid moving down to the chamber, toning fluid being held staionary and in equilibrium in an essentially vertical meniscus filling the volum of the chamber; and

control means operating the controllable valve to admit atmosphere to the supply system at a controlled rate to reduce the negative pressure in the supply system so that the toning fluid may move down through the cham-

ber with a speed of movement of the toning fluid in the chamber essentially equal to the speed of movement of the member so that the toning fluid remains essentially stationary relative to the member as it flows down through the chamber with the toning fluid toning the latent image carried on the member.

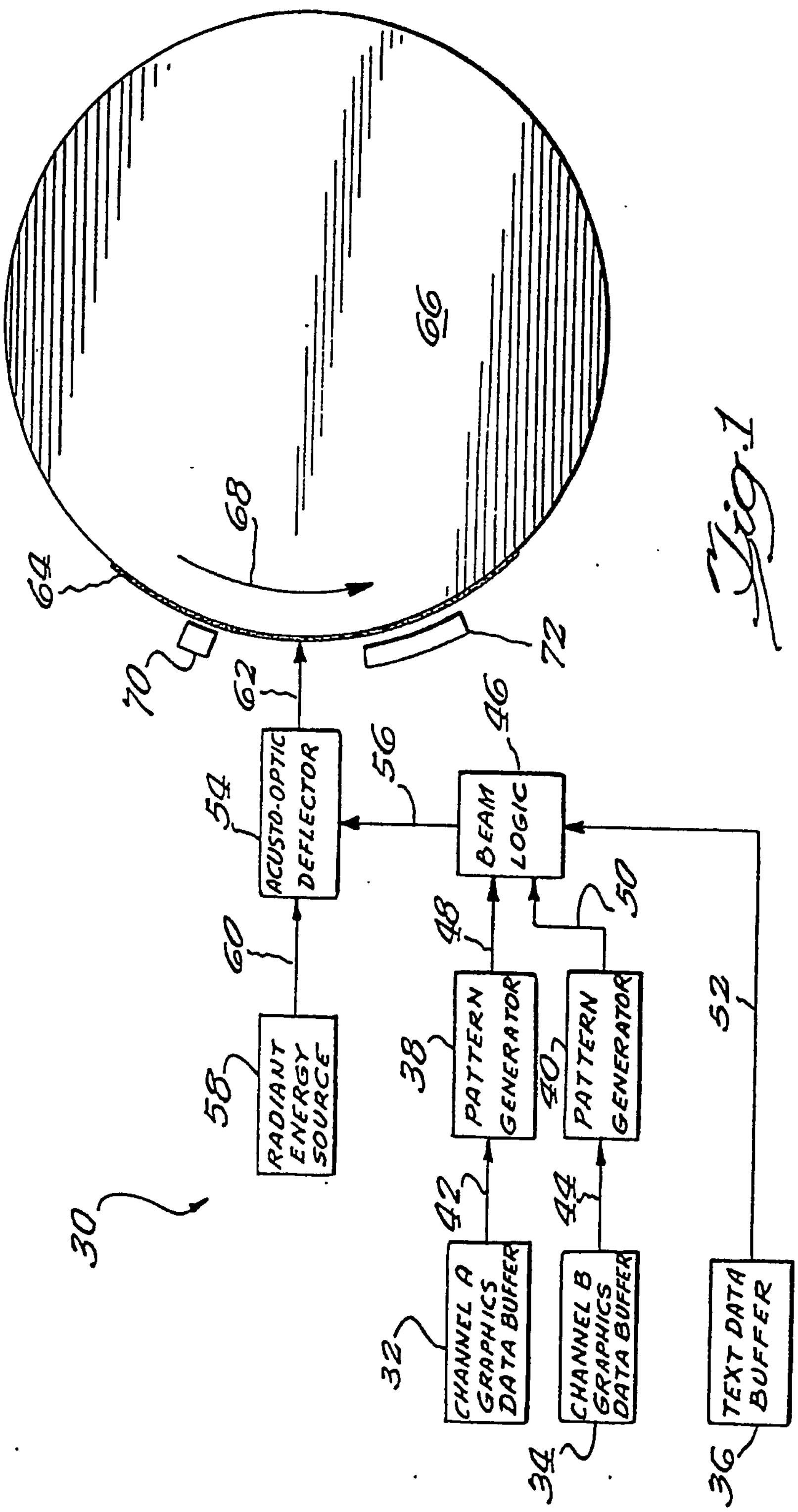
RADIANT ENERGY SOURCE
ACUSTO-OPTIC DEFLECTOR
BEAM LOGIC
PATTERN GENERATOR
PATTERN GENERATOR
CHANNEL A GRAPHICS DATA BUFFER
CHANNEL B GRAPHICS DATA BUFFER
TEXT DATA BUFFER
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72

Fig. 1

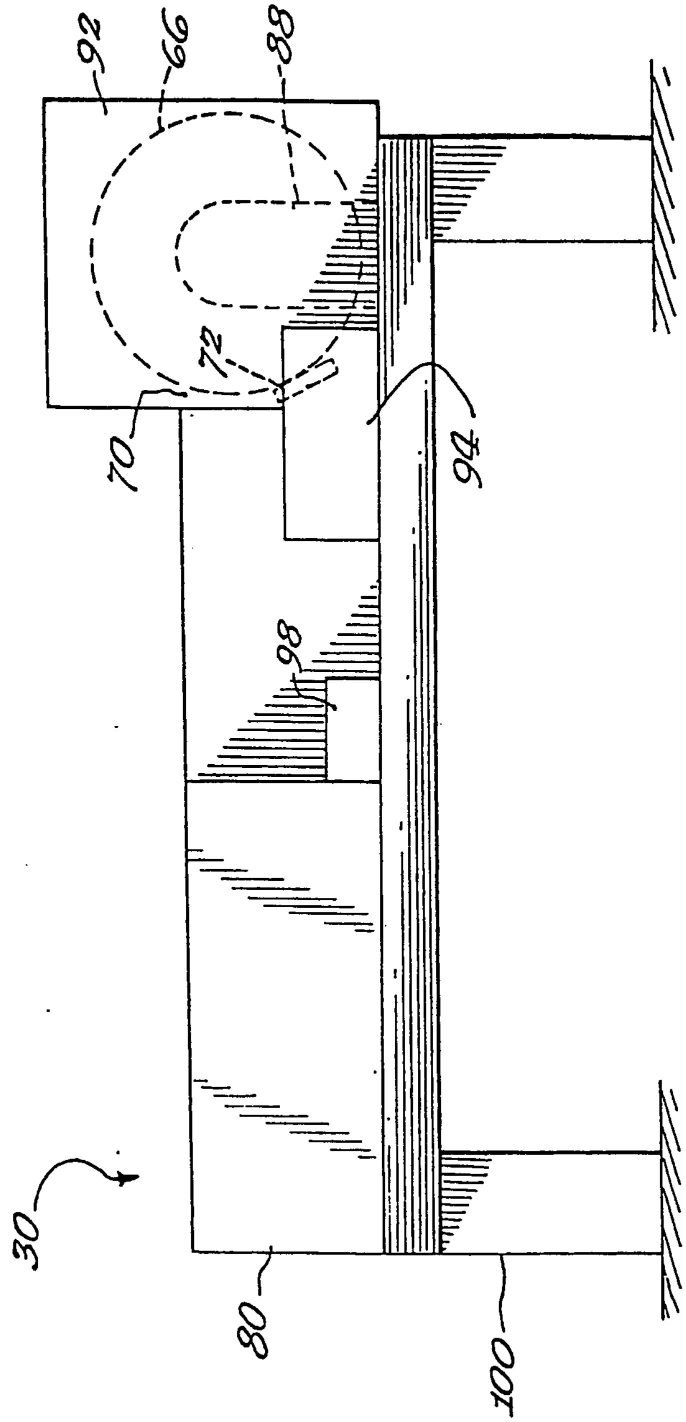

Fig. 2

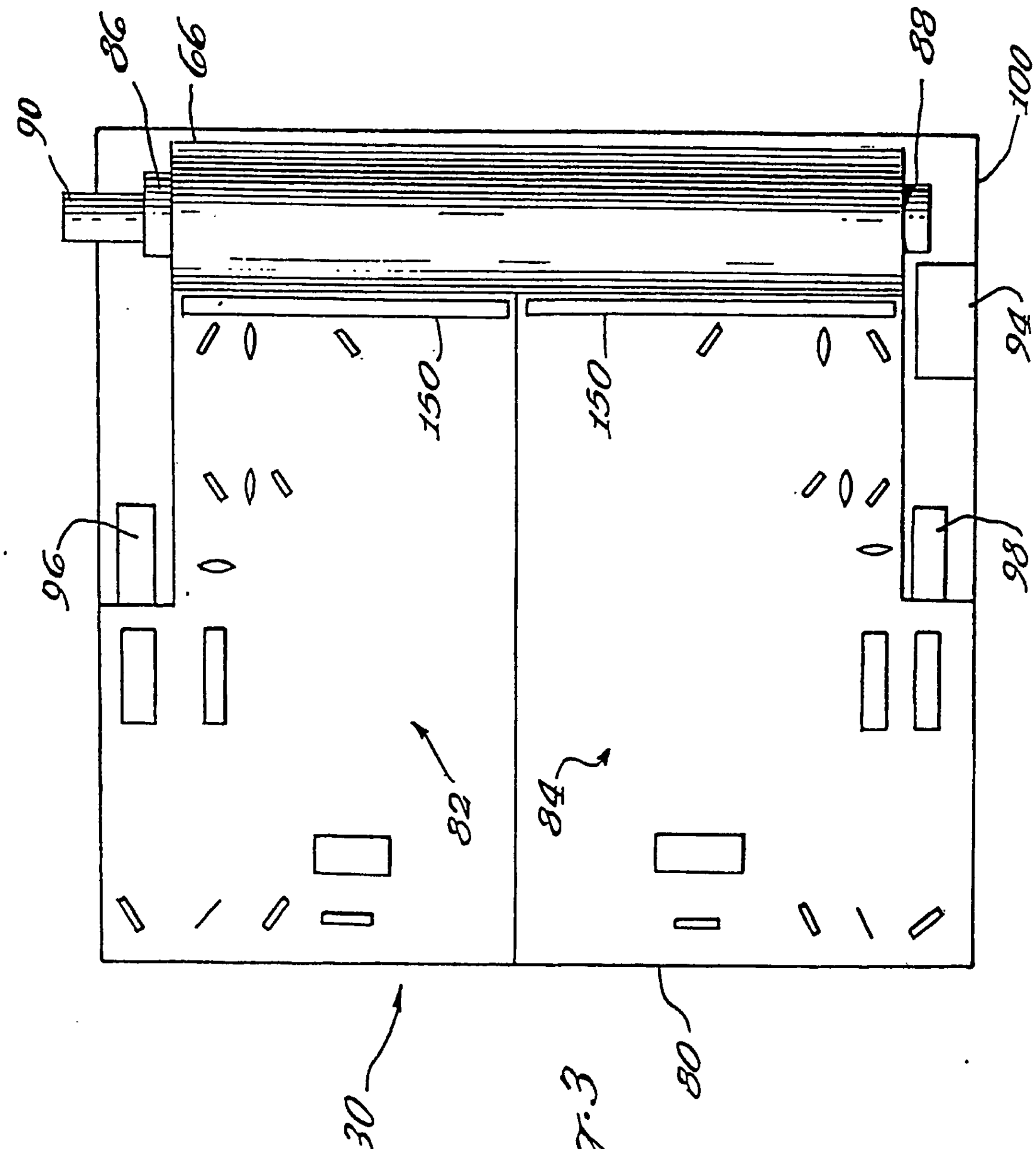

Fig. 3

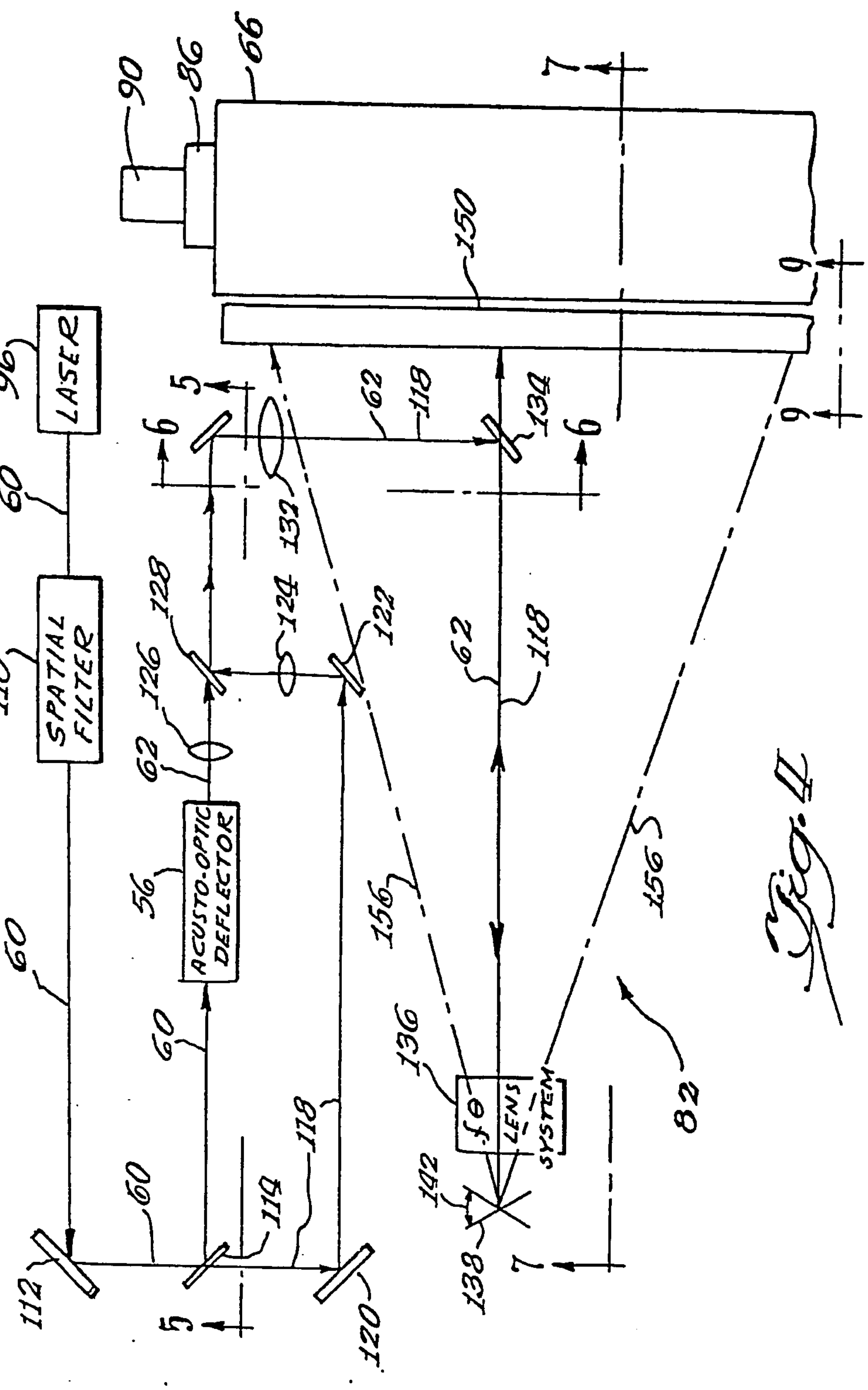
LASER
96
60
SPATIAL FILTER
110
ACUSTO-OPTIC DEFLECTOR
56
62
126
128
124
122
132
134
118
5
6
7
9
66
86
90
150
156
136
fθ LENS SYSTEM
142
138
112
114
120
82

Fig. 11

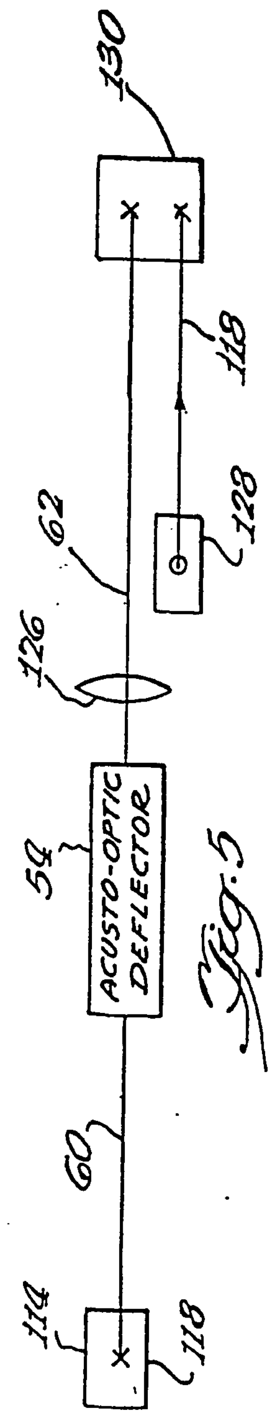
130
118
128
62
126
ACUSTO-OPTIC DEFLECTOR
54
60
114
118

Fig. 5

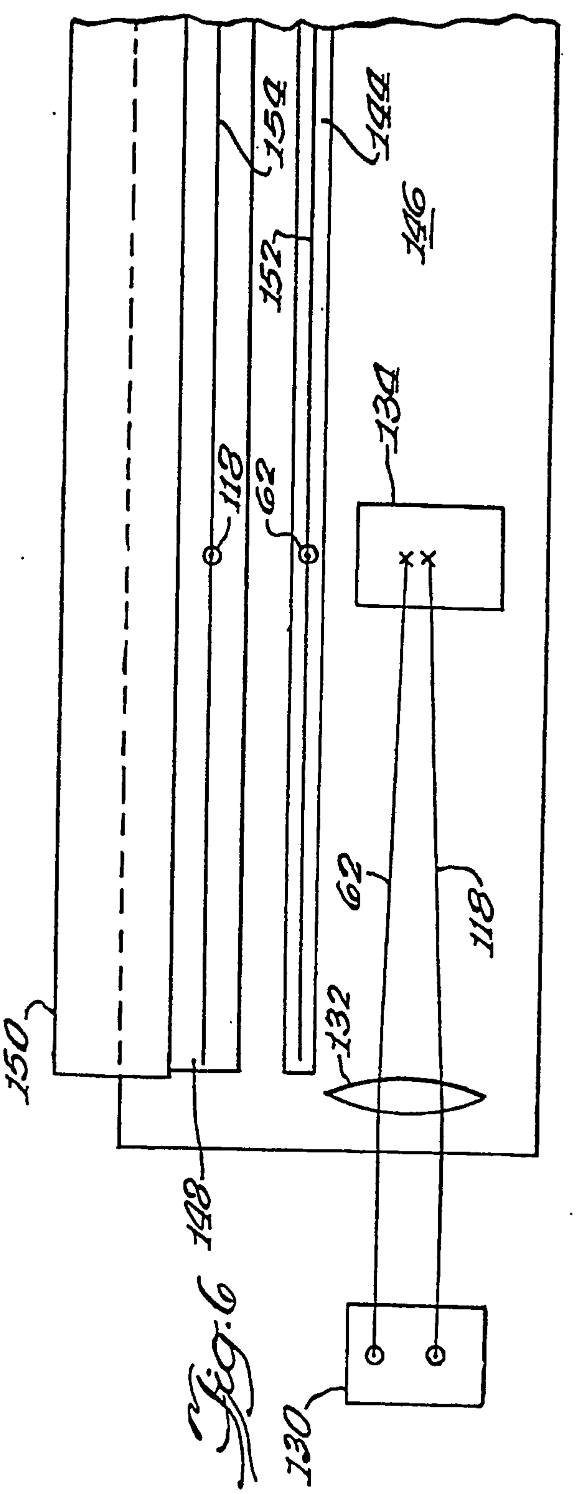
154
144
146
152
134
118
62
62
118
150
132
148
130

Fig. 6

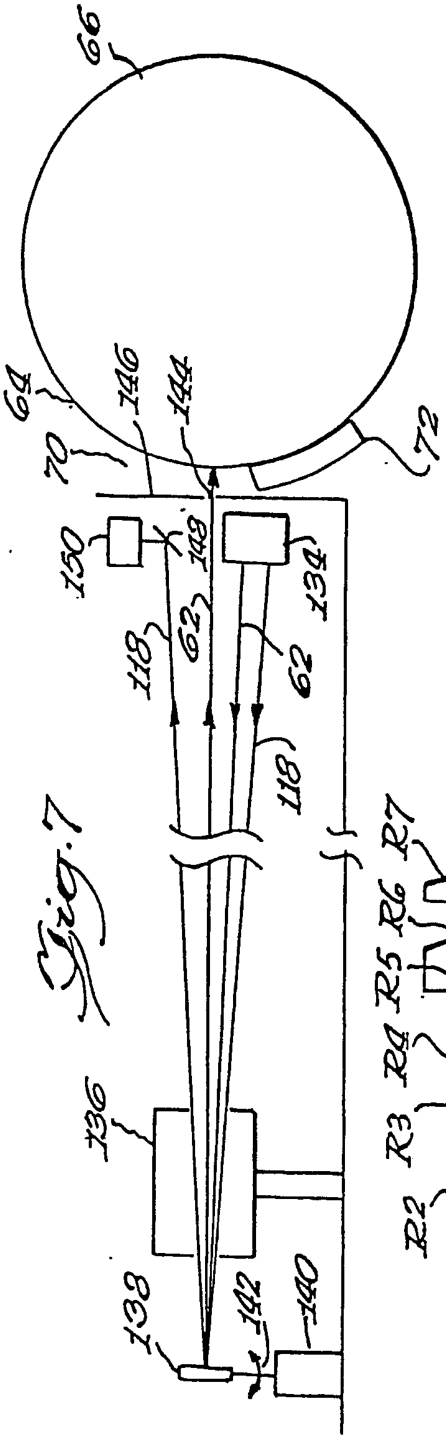
66
64
70
146
144
72
150
149
134
118
62
62
118
136
138
142
140

Fig.7

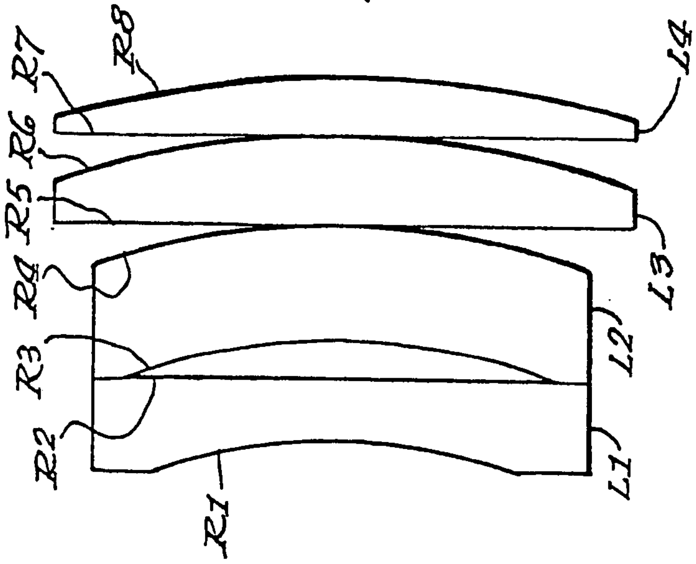
R8
R7
R6
R5
R4
R3
R2
R1
L4
L3
L2
L1

Fig.8

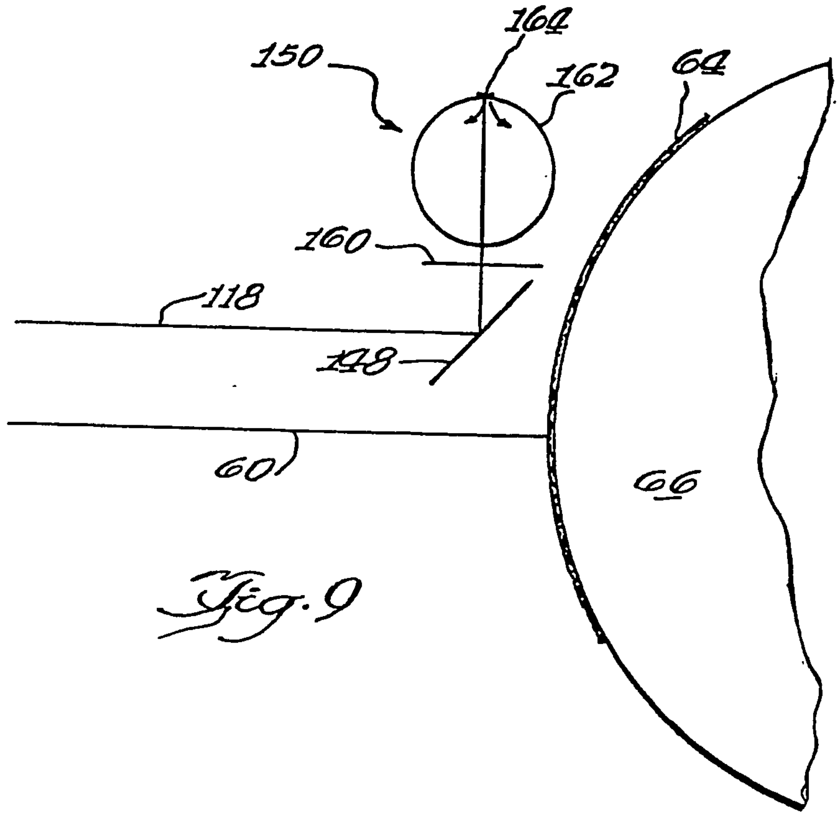

Fig. 9

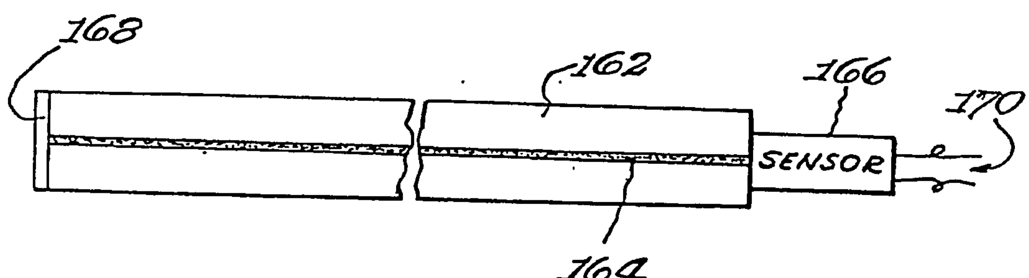

Fig. 10

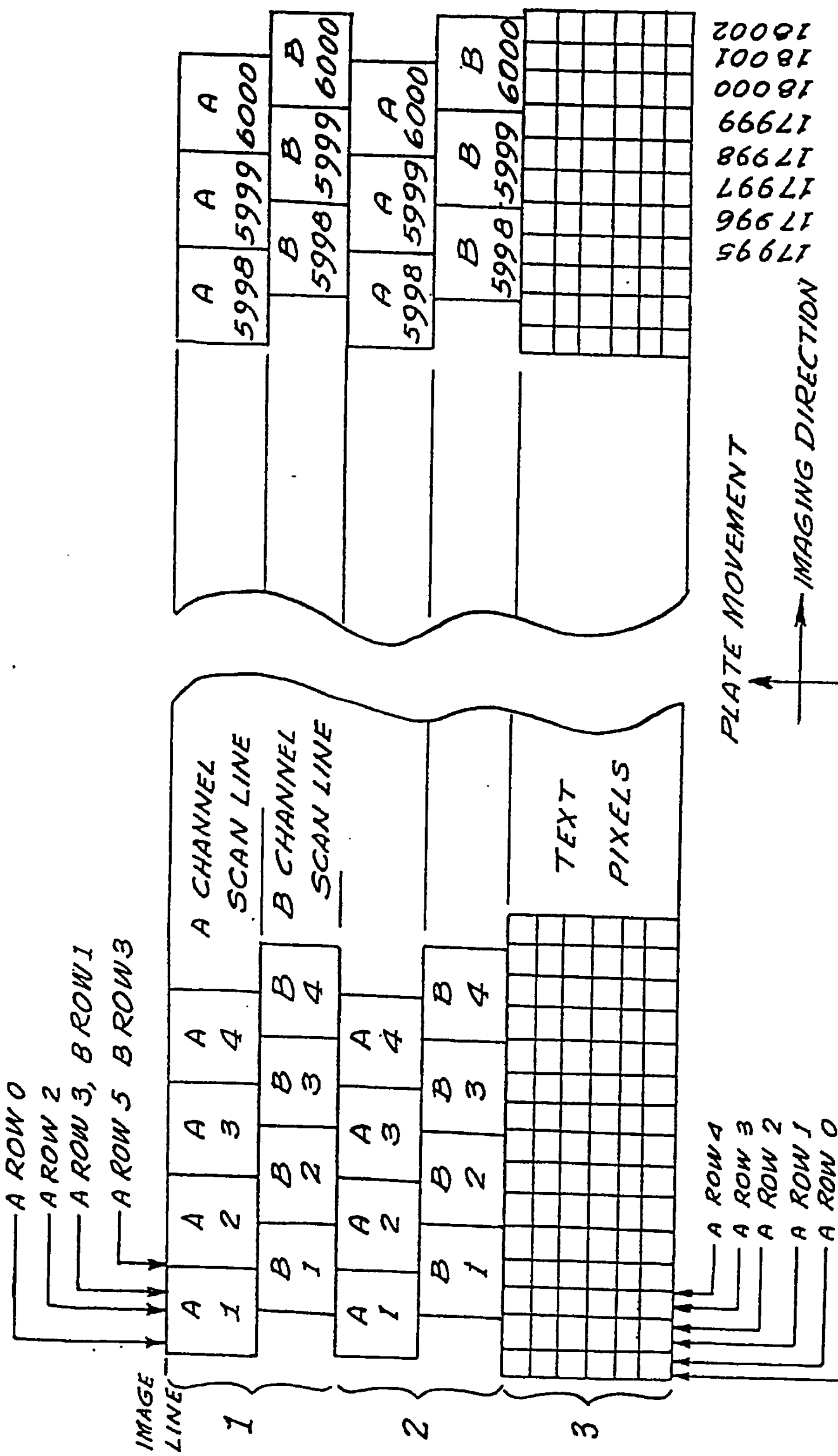
A ROW 0
A ROW 2
A ROW 3, B ROW 1
A ROW 5 B ROW 3
A CHANNEL SCAN LINE
B CHANNEL SCAN LINE
TEXT PIXELS
IMAGE LINE
1
2
3
A ROW 4
A ROW 3
A ROW 2
A ROW 1
A ROW 0
A ROW 5
PLATE MOVEMENT
IMAGING DIRECTION
5998
5999
6000
17995
17996
17997
17998
17999
18000
18001
18002

Fig. 11

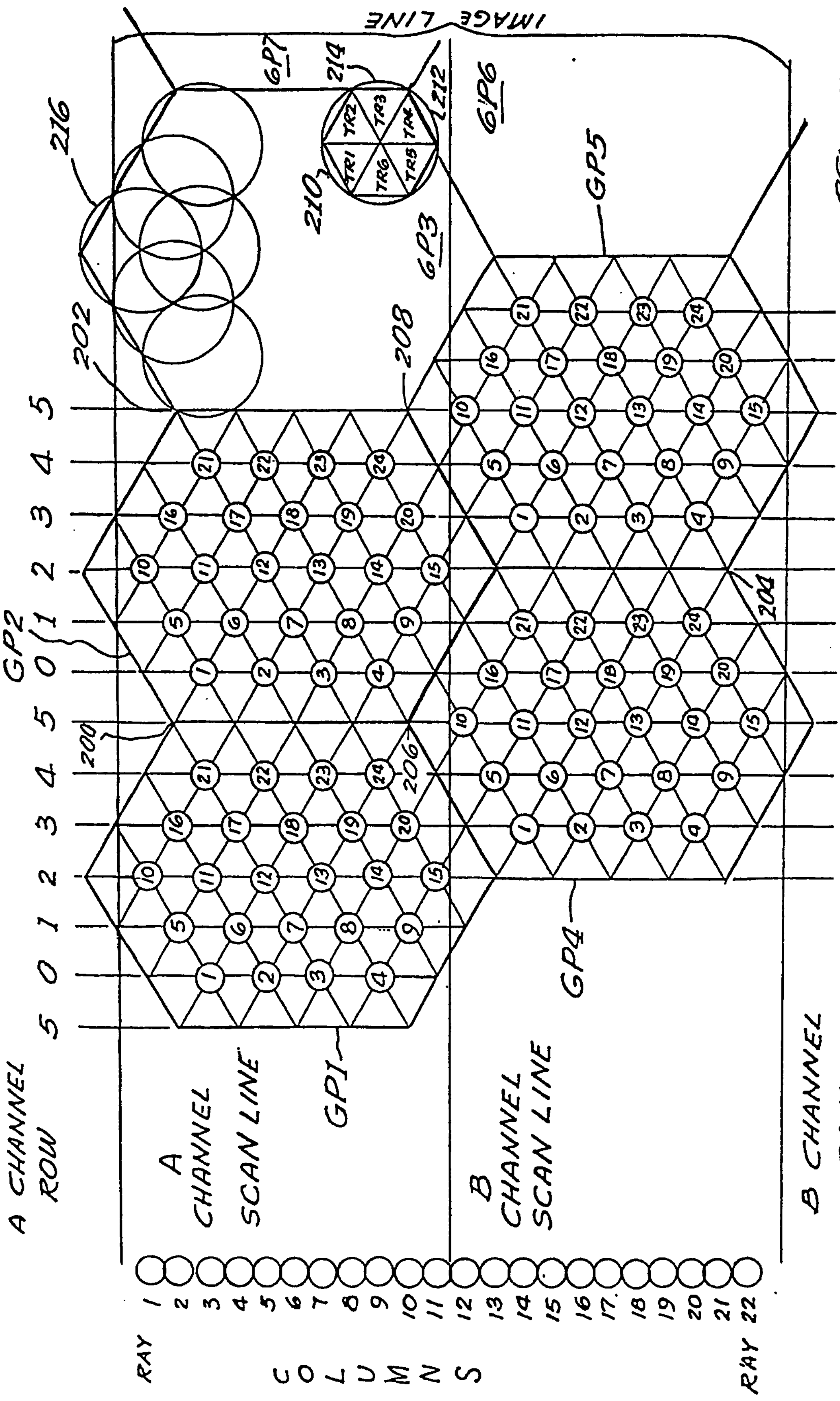
IMAGE LINE
GP7
214
212
GP6
216
TR1
TR2
TR3
TR4
TR5
TR6
210
GP3
GP5
202
208
GP2
200
206
204
GP4
GP1
A CHANNEL ROW
A CHANNEL SCAN LINE
B CHANNEL SCAN LINE
B CHANNEL ROW
RAY
COLUMNS
RAY

Fig.12

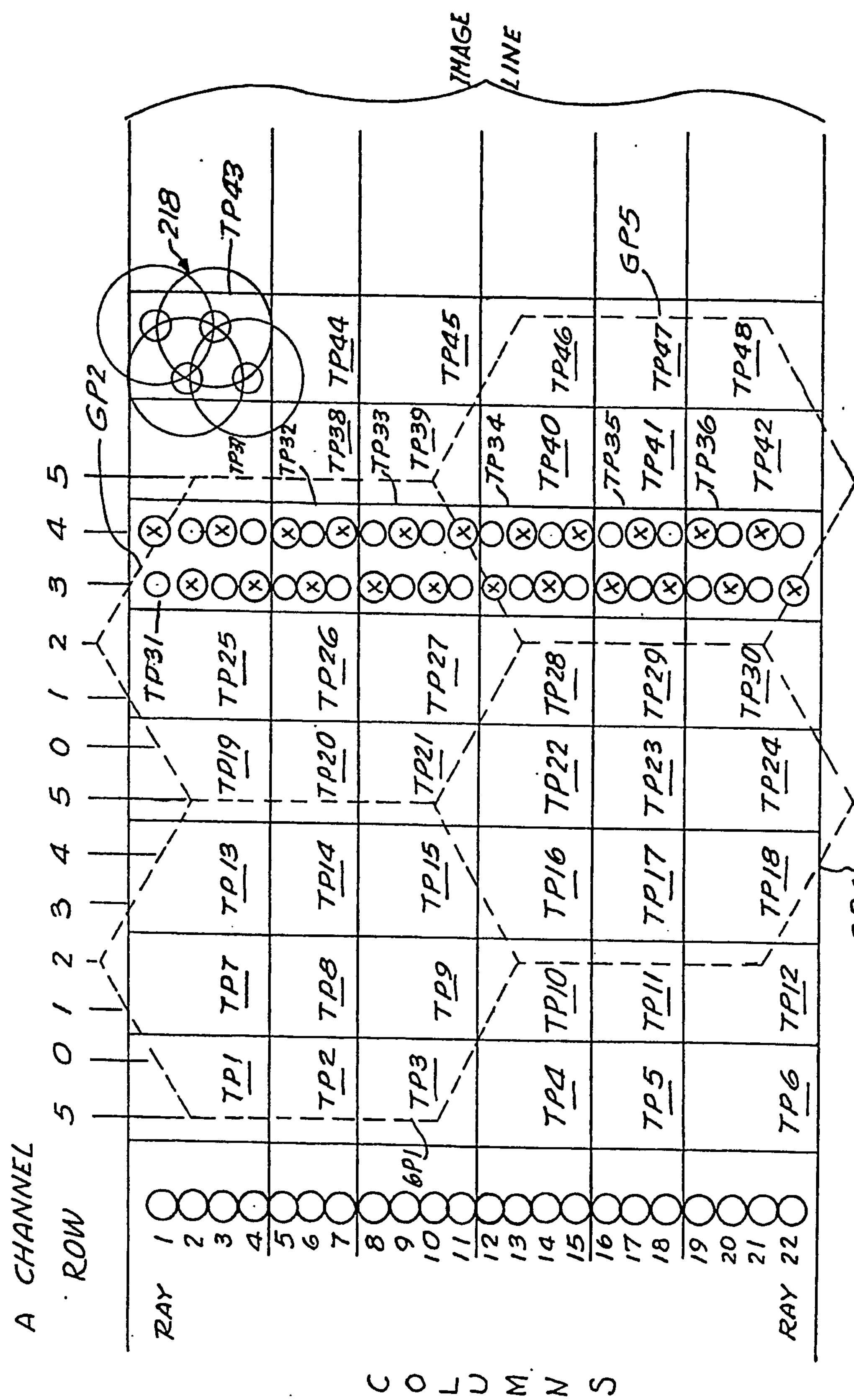
IMAGE LINE
A CHANNEL ROW
RAY
RAY
COLUMNS
218
TP43
GP2
GP5
GP4
GP1
TP1
TP2
TP3
TP4
TP5
TP6
TP7
TP8
TP9
TP10
TP11
TP12
TP13
TP14
TP15
TP16
TP17
TP18
TP19
TP20
TP21
TP22
TP23
TP24
TP25
TP26
TP27
TP28
TP29
TP30
TP31
TP32
TP33
TP34
TP35
TP36
TP38
TP39
TP40
TP41
TP42
TP44
TP45
TP46
TP47
TP48

Fig.13

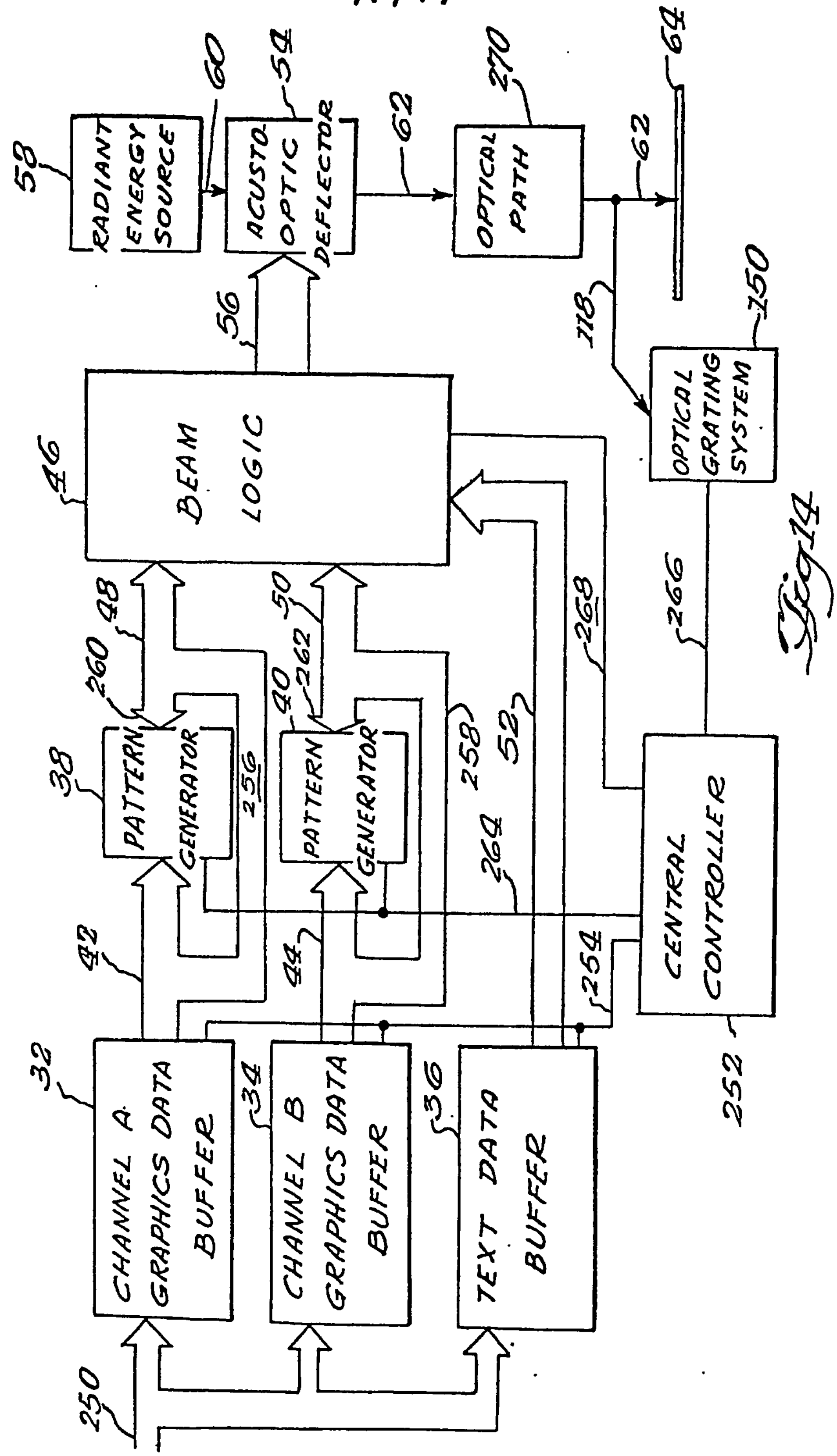
RADIANT ENERGY SOURCE
58
60
ACUSTO OPTIC DEFLECTOR
54
62
OPTICAL PATH
270
62
64
118
OPTICAL GRATING SYSTEM
150
BEAM LOGIC
46
56
48
260
50
262
PATTERN GENERATOR
38
256
PATTERN GENERATOR
40
258
52
268
264
266
CENTRAL CONTROLLER
252
254
42
44
CHANNEL A GRAPHICS DATA BUFFER
32
CHANNEL B GRAPHICS DATA BUFFER
34
TEXT DATA BUFFER
36
250

Fig 14

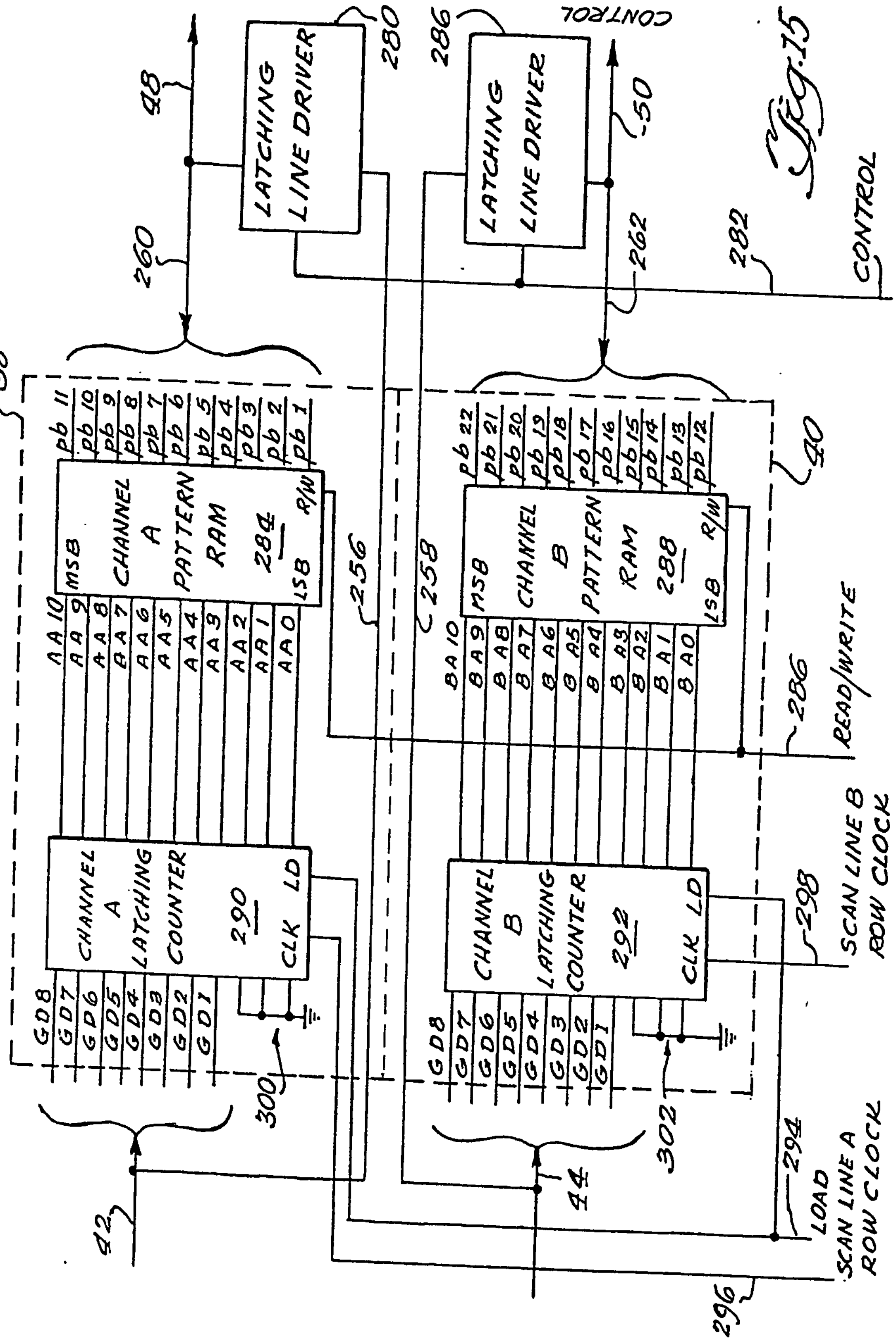
LATCHING LINE DRIVER
280
LATCHING LINE DRIVER
286
CONTROL
48
50
260
262
282
CONTROL
38
40
CHANNEL A PATTERN RAM 284
MSB
LSB
R/W
pb 11
pb 10
pb 9
pb 8
pb 7
pb 6
pb 5
pb 4
pb 3
pb 2
pb 1
AA 10
AA 9
AA 8
AA 7
AA 6
AA 5
AA 4
AA 3
AA 2
AA 1
AA 0
CHANNEL B PATTERN RAM 288
pb 22
pb 21
pb 20
pb 19
pb 18
pb 17
pb 16
pb 15
pb 14
pb 13
pb 12
BA 10
BA 9
BA 8
BA 7
BA 6
BA 5
BA 4
BA 3
BA 2
BA 1
BA 0
256
258
286
READ/WRITE
CHANNEL A LATCHING COUNTER 290
CLK
LD
CHANNEL B LATCHING COUNTER 292
GD8
GD7
GD6
GD5
GD4
GD3
GD2
GD1
298
SCAN LINE B ROW CLOCK
300
302
42
44
294
LOAD SCAN LINE A ROW CLOCK
296

Fig.15

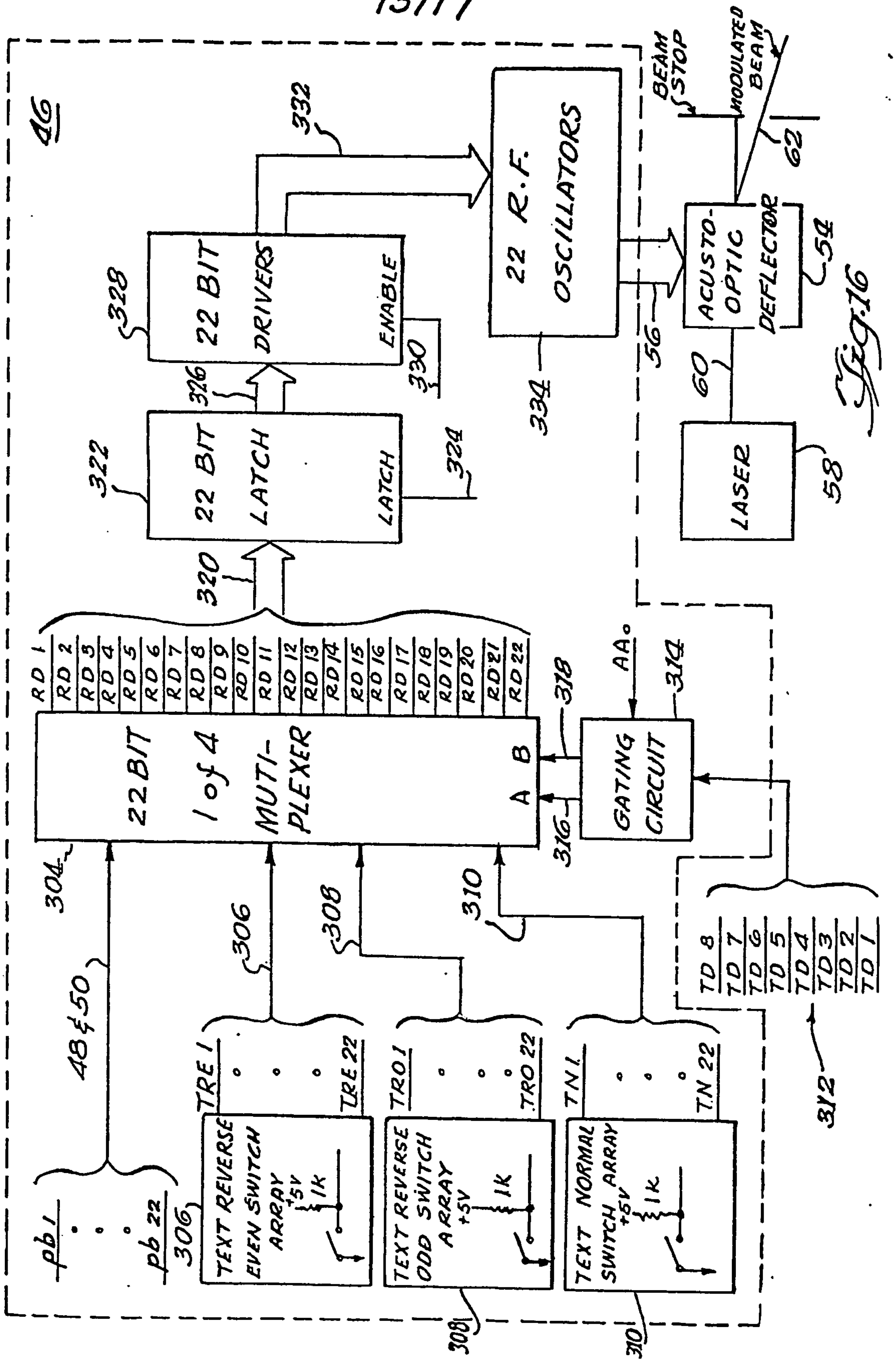
46
22 BIT DRIVERS
ENABLE
328
330
332
22 R.F. OSCILLATORS
334
BEAM STOP
MODULATED BEAM
62
ACUSTO-OPTIC DEFLECTOR
54
56
60
LASER
58
22 BIT LATCH
LATCH
322
324
326
320
RD 1 RD 2 RD 3 RD 4 RD 5 RD 6 RD 7 RD 8 RD 9 RD 10 RD 11 RD 12 RD 13 RD 14 RD 15 RD 16 RD 17 RD 18 RD 19 RD 20 RD 21 RD 22
22 BIT 1 of 4 MUTI-PLEXER
A B
304
318
316
AA₀
GATING CIRCUIT
314
TD 8 TD 7 TD 6 TD 5 TD 4 TD 3 TD 2 TD 1
312
48 & 50
306
308
310
pb 1
pb 22
TRE 1
TRE 22
TRO 1
TRO 22
T.N 1
T.N 22
TEXT REVERSE EVEN SWITCH ARRAY
TEXT REVERSE ODD SWITCH ARRAY
TEXT NORMAL SWITCH ARRAY
+5V
1K

Fig.16

	USED TO CONTROL
TD 8	NOT USED
TD 7	CONTROL 1= NORMAL 0- REVERSE
TD 6	RAYS 19-22
TD 5	RAYS 16-18
TD 4	RAYS 12-15
TD 3	RAYS 8-11
TD 2	RAYS 5-7
TD 1	RAYS 1-4

Fig-17

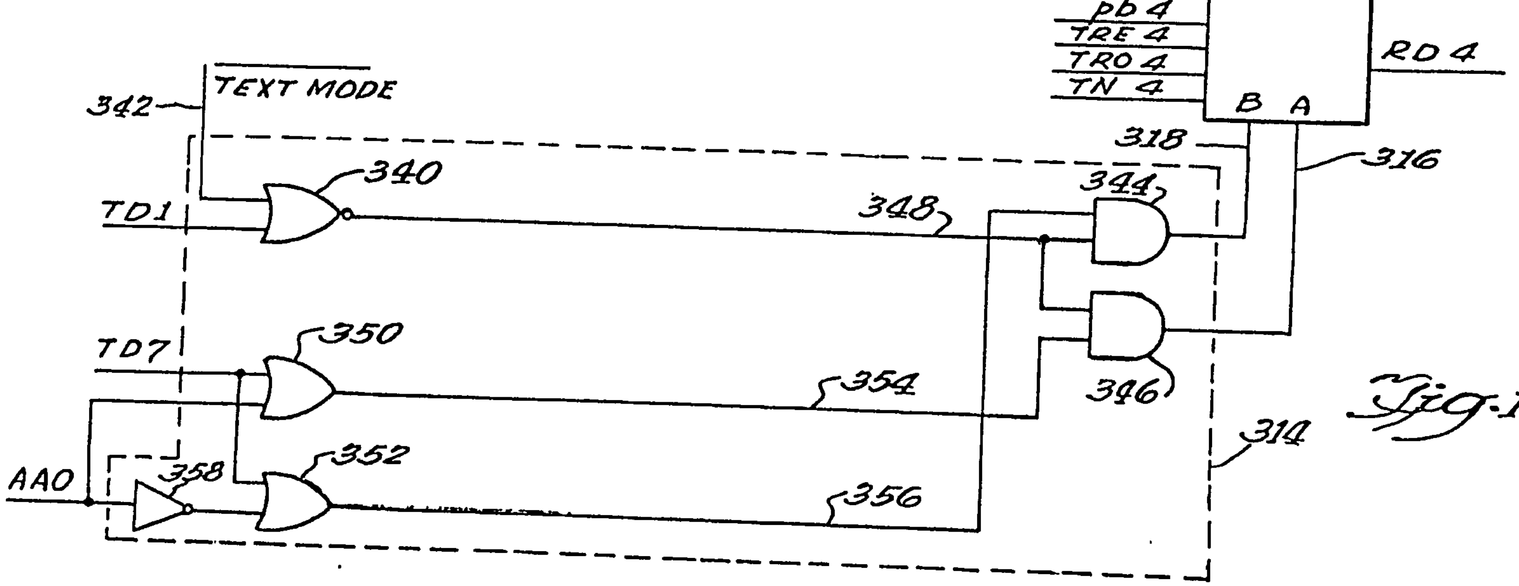

Fig-18

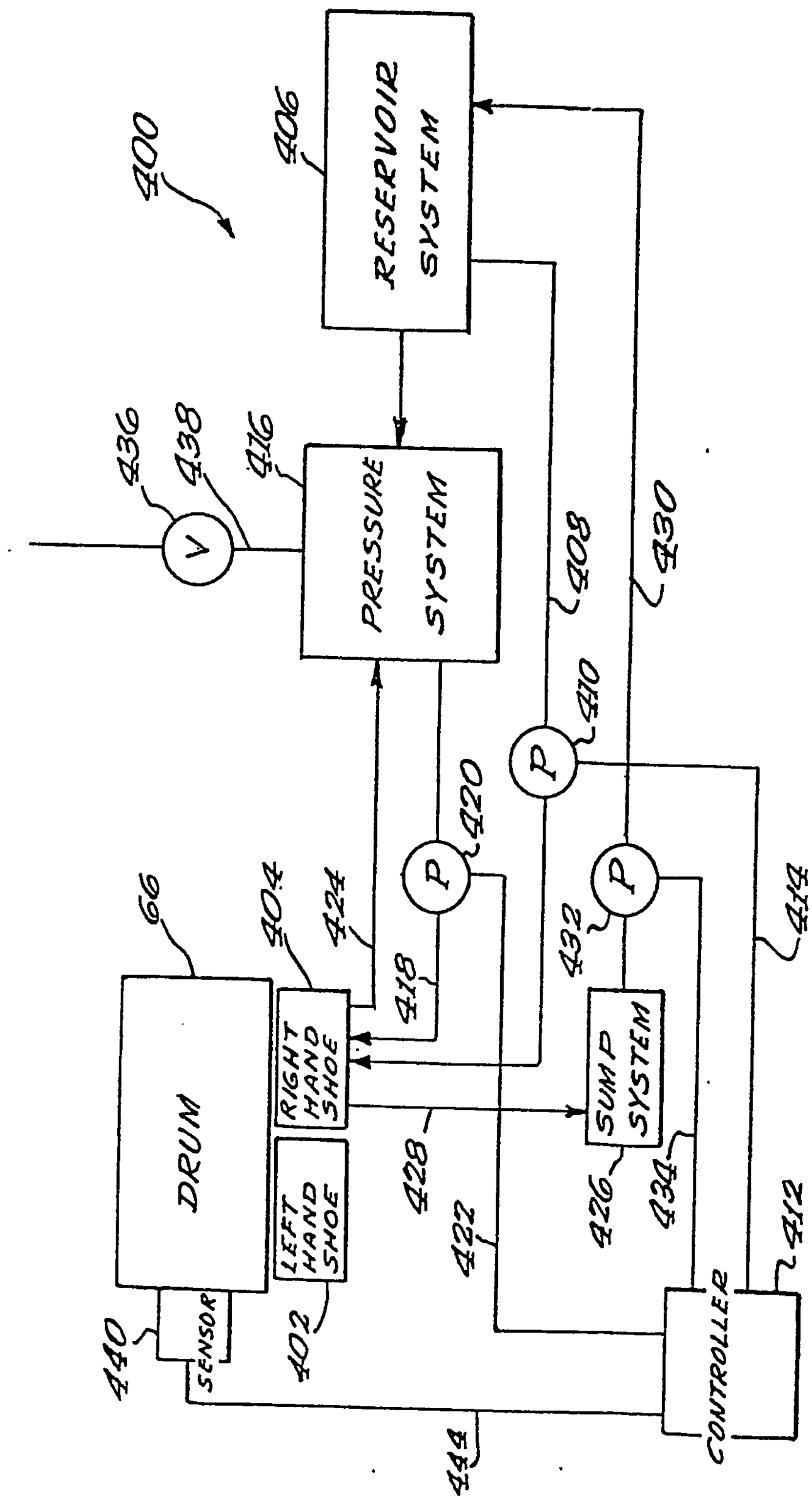
400
RESERVOIR SYSTEM
406
PRESSURE SYSTEM
416
V
436
438
408
430
P
410
P
420
P
432
DRUM
66
RIGHT HAND SHOE
404
424
418
LEFT HAND SHOE
402
SENSOR
440
SUMP SYSTEM
426
428
422
434
414
412
CONTROLLER
444

Fig.19

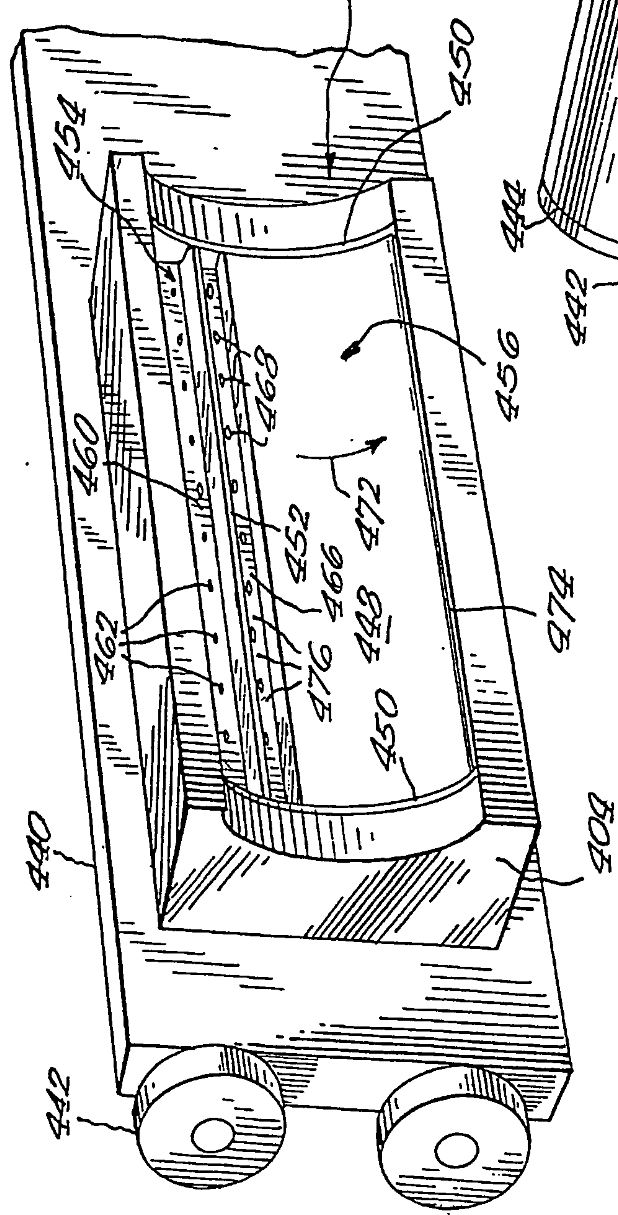
446
450
454
456
460
468
452
466
472
462
476
448
474
450
440
404
442

Fig. 21

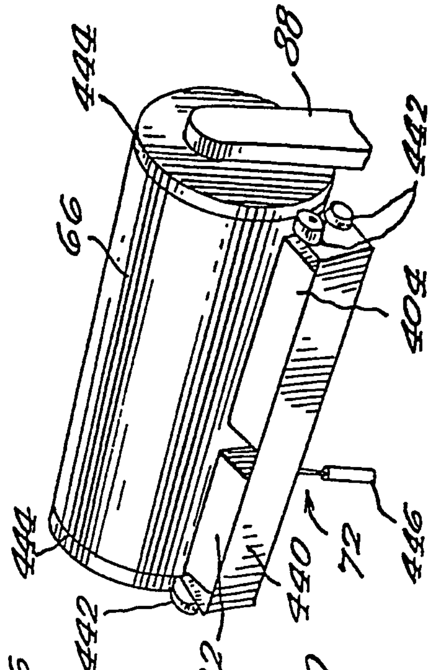
444
88
442
66
404
444
442
402
440
72
446

Fig. 20

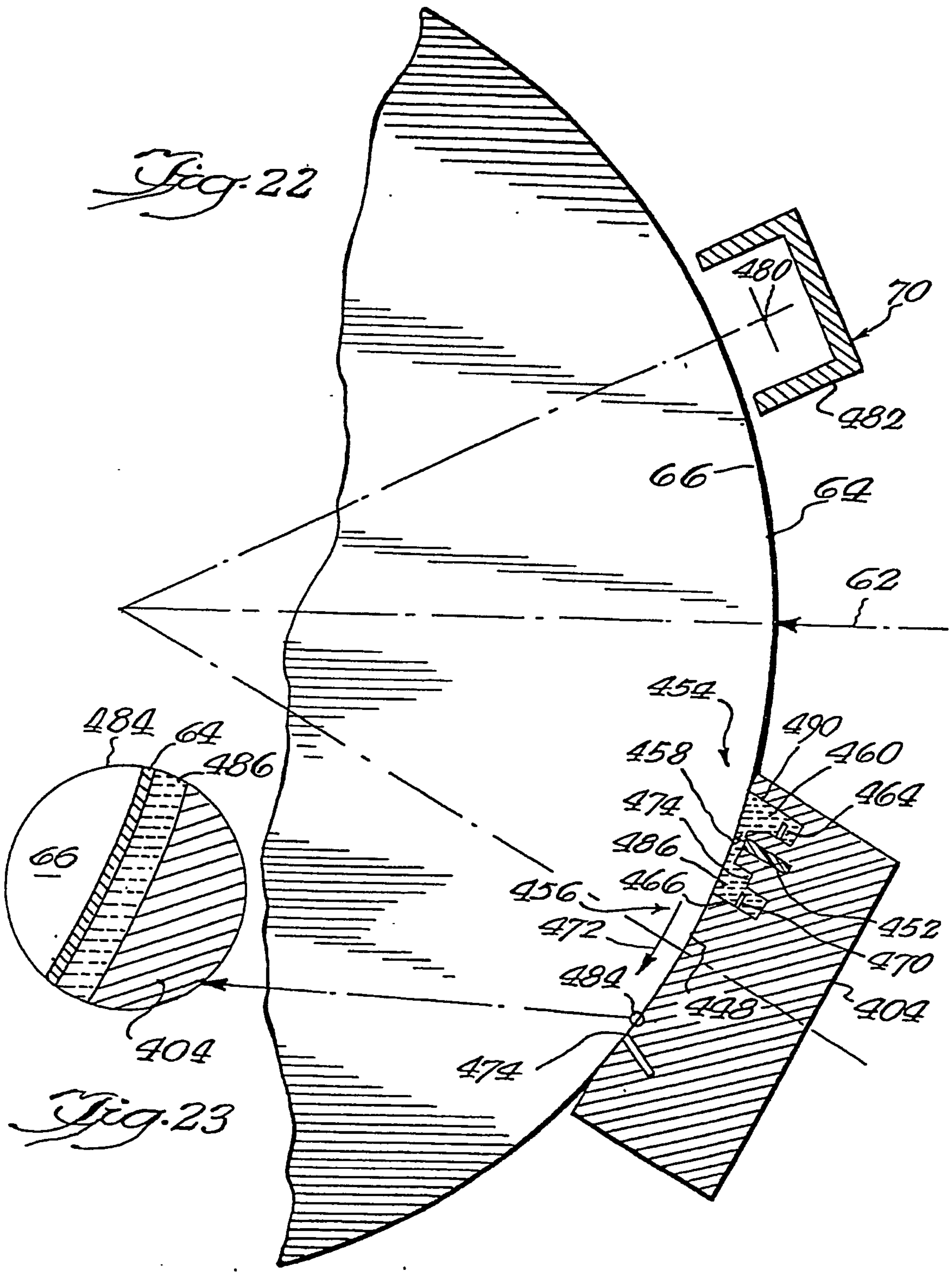
Fig. 22
480
70
482
66
64
62
454
490
460
458
464
474
486
452
456
466
470
472
404
484
448
474
484
64
486
66
404
Fig. 23